HYDROCARBON PROCESSING AND
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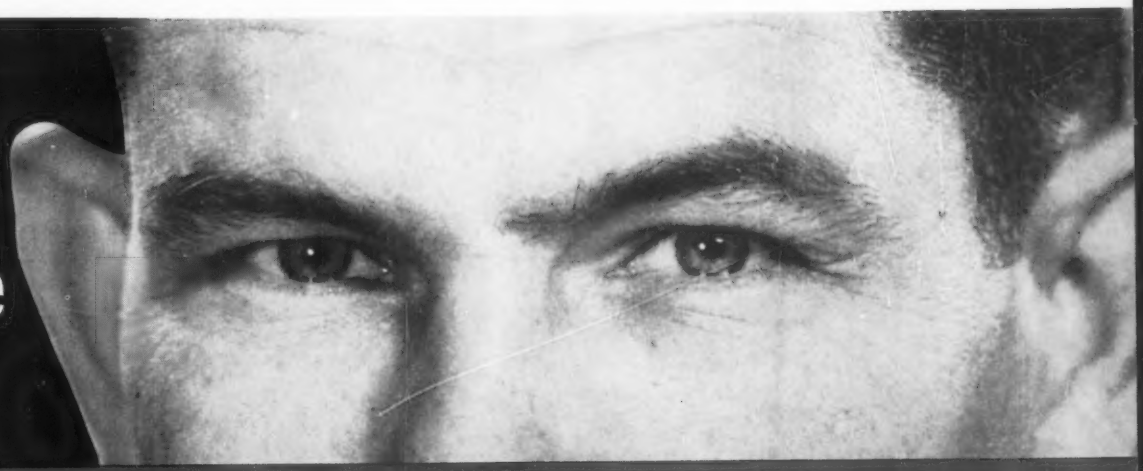

NOW is the time to plan

Your Retirement

PAGE 127

JUNE 1961

Lower Costs for Hydrocracking 147
What's New in TEMA Standards 157
Take Another Look at Phenol 193
How to Make Questions Pay Off 215

YARWAY news briefs

from **Yarnall-Waring Company,** *Philadelphia 18, Pa.*

BRANCH OFFICES IN 19 UNITED STATES CITIES • SALES REPRESENTATIVES THROUGHOUT THE WORLD
STEAM TRAPS STOCKED AND SOLD BY 270 LOCAL INDUSTRIAL DISTRIBUTORS

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ENTHUSIASTIC APPROVAL!

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TEXAS INDUSTRIAL

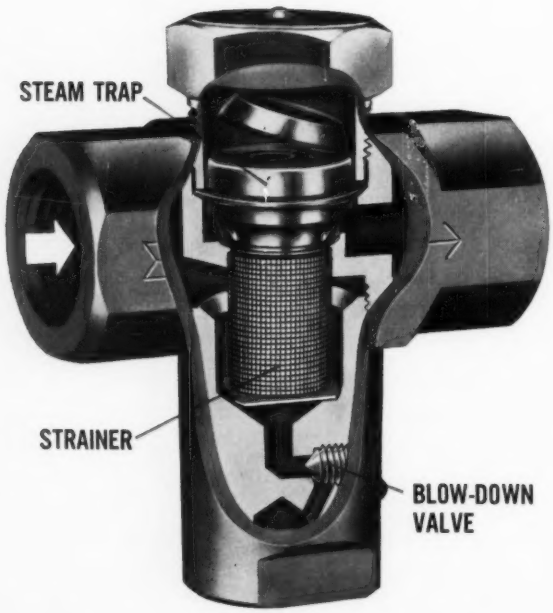
"We want 100 immediately. They meet our confined space needs perfectly."
WISCONSIN PACKER

"Ordering 60 as first part of new standardization program."
LOUISIANA REFINERY

"We'll start with 24—more later."
OHIO PETRO-CHEMICAL

So it goes—industry's welcome to the new Yarway Series 130 combination steam trap has been a warm one. Already manufacturing quotas have been doubled to meet the demand. Yarway distributors everywhere are busy answering their customers' requests for demonstrations.

What will the new Series 130 do for you? Consider these advantages:



COMPACT COMBINATION SAVES SPACE, MONEY, MAINTENANCE ON LIGHT LOAD APPLICATIONS

Steam trap, strainer, blow-down valve combination simplifies trapping hook-ups—saves up to 30% in time and materials over ordinary hook-ups.

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All stainless steel construction, woven stainless steel strainer screen, replaceable trap valve-seat assembly, Allen wrench-operated blow-down valve—make maintenance easy.

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Try this trap on your steam main drips, steam tracer lines, meter boxes or any other of thousands of light condensate load applications. Call your nearby Yarway distributor today—or write us for more details.

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VOL. 40, NO. 6 JUNE 1961

HYDROCARBON PROCESSING AND
Petroleum
REFINER

A Gulf Publishing Company Publication

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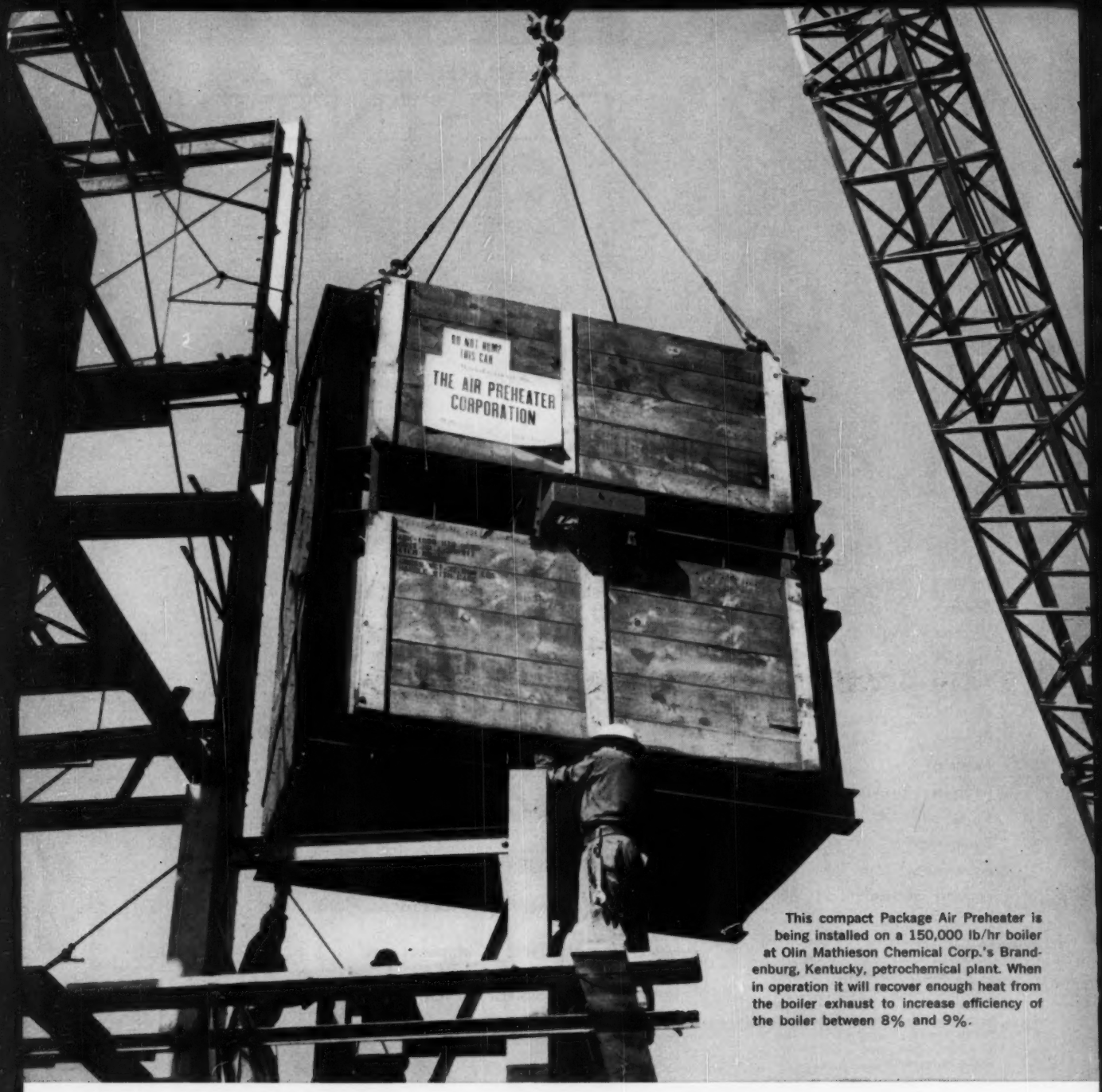

This compact Package Air Preheater is being installed on a 150,000 lb/hr boiler at Olin Mathieson Chemical Corp.'s Brandenburg, Kentucky, petrochemical plant. When in operation it will recover enough heat from the boiler exhaust to increase efficiency of the boiler between 8% and 9%.

OLIN MATHIESON RECOVERS 360°F FROM BOILER EXHAUST WITH 11½′ x 11′ x 8′ PREASSEMBLED LJUNGSTROM® PACKAGE AIR PREHEATER

Olin Mathieson specified a Ljungstrom Package Air Preheater because it saves space as well as fuel. Mathieson's Ljungstrom occupies only about 1000 cubic feet, but cuts boiler exhaust temperature from 680°F to 320°F — puts 360° of heat back to work in the boiler.

The compact preassembled Package Air Preheater is ready to run when it's delivered—just connect to the power line and ducts, and it's on-stream. You make big savings on installation because there's no on-the-spot erection.

You can use a Ljungstrom Package Air Preheater on boilers from 25,000 to 250,000 pounds of steam per hour. For more information, write today for your free copy of a 14-page booklet.

THE AIR PREHEATER CORPORATION

60 East 42nd Street, New York 17, N. Y.

A Quick Look at This Issue

☐ **How to Retire . . .** If you've ever given much thought to the day you'll step out of your job and into the world of retirement, chances are you've asked yourself these questions and many more: How will I use my leisure time? What kind of investment program should I have to provide permanent income? What are my health and longevity prospects? Where will I live? These are all questions you must resolve before (preferably long before) stepping into your new life as a retiree.

The success of your retired life will depend largely on how well you plan for it. In this special report, written by a successful retiree who did plan ahead, you'll get the answers to how you can set realistic retirement goals. Planning will lead you to a happy life in your reclining years. Here are the topics you'll find to help you plan your retirement:

- Preparing to Retire
- How Long Will You Live
- Start Your Plans Now
- Continue Your Retirement Plans
- Old Age—Everyone's Problem
- Your Life After 65
- Your Utopia

Start planning your retirement now, beginning with the special report on **Page 127.**

☐ **Now Revise Those Hydrocracking Costs . . .** Recent commercial-scale operations feeding heavy catalytic cycle oil and heavy straight run gas oil demonstrate the flexibility of the Isocracking process. See how latest design studies show substantial reductions in investments and operating costs for this process on **Page 147.**

☐ **Check These Points When Designing Knock-Out Drums . . .** For light mist entrainment (less than 1 gpm of liquid separated) use a vertical drum. For heavy vapor-liquid separations, use a horizontal drum. These two rules of thumb for designing knock-out drums will help you pick the correct drum type. For a more detailed study of the design points to cover, turn to **Page 155.**

☐ **New TEMA Standards Compared to Old . . .** "TEMA R and TEMA C are meaningful specifications. TEMA alone is not." The author compares the two side by side. The new fourth edition, 1959, (revised in 1960) contains a definition of nominal exchanger size that never existed before. For example details on all the changes in the new TEMA standards, turn to **Page 157.**

☐ **Graphs Cut Exchanger Design Time . . .** If you know the maximum allowable pressure drop on the shell and tube sides and the heat duty in Btuh, you can find the minimum exchanger required with nomographs included in this article. This time-saving method applies to gases and liquids under viscous or turbulent flow conditions, when there is no change in phase. For details see **Page 165.**

☐ **Equipment Cost Data File (Part 3) . . .** To obtain cost data on spheres and double-deck floating roof tanks, clip this article starting on **Page 173.**

☐ **Check This Payout on Crude Desalting . . .** Compare your crude treating situation with the example given here. See how much it is worth to have crude desalting in your plant by turning to **Page 175.**

☐ **Thermo Data for Petrochemicals (Part 30) . . .** This article covers the primary SH compounds ranging from methanethiol through n-decanethiol. To get these data for your thermo notebook, see **Page 179.**

☐ **Rigging Techniques for Process Plants . . .** A basic skill such as rigging requires the application of sound engineering principles and "Yankee" ingenuity. See how a fractionating column is rigged, light towers are set and how the Chicago boom is used, **Page 183.**

☐ **A Faster Way to Estimate Critical Temperatures of Natural Gas Mixtures . . .** Most process designers have used some of the long, cumbersome methods for estimating the critical temperatures of complex mixtures. Now you can save your time, temper and energy using the Beck method, on **Page 188.**

☐ **Use Fractions for Recycle Balances (Part 2) . . .** For details on a method, which works on most chemical processes, for handling more complex recycle systems be sure and turn to **Page 189.**

☐ **What Are the Processes and Prospects for Phenol? . . .** Phenol is fast becoming more and more a petrochemical through many new processes. For growth patterns, end-use distribution and future prospects for phenol, turn to **Page 193.**

☐ **How Much of Your Knowledge Is Yours? . . .** As technology gets more complex, it's more important that engineers understand the law of proprietary rights. Here's your chance to learn just what part of your knowhow belongs to you, what part is your employer's, and how the courts dealt with some cases in point. See **Page 209.**

☐ **Tough Management Gets Results . . .** Toughness need not depict you as hardheaded, aggressive or belligerent. On the contrary, used with discretion, it can be a constructive element in your dealings with others. To learn how toughness can be your servant, turn to **Page 213.**

☐ **You Can Make Your Questions Pay Off . . .** The question is one of the most-used media of communication in the management of men—yet it is the least developed as a means to get and transmit information. To learn how the art of intelligent, effective, systematic questioning can improve your administrative ability, turn now to **Page 215.**

Model 3195 centrifugal pump

WHY THIS DUCTILE IRON PUMP HITS 500°F...WITHOUT RISK...WITH LESS COST

Now you can pump liquids as hot as 500° F, low-specific-gravity hydrocarbons and other tough services at working pressures to 275 PSIG without the extra cost of carbon steel.

Ductile Iron resists stress, impact and high pressure as much as carbon steel does—because it has properties similar to carbon steel's.

	Tensile Strength	Yield Strength	Elon-gation	Notes
Cast Iron A48-56	30,000 PSI	0	0	
Goulds Ductile Iron (ASTM A395-56T)	60,000 to 70,000 PSI	45,000 to 50,000 PSI	15-25%	As heat treated to full ferritized anneal
Carbon Steel ASTM A-216-59T-WCB	70,000 PSI	36,000 PSI	22%	

3 Tests Prove Your Pump's Toughness. Each heat of Ductile Iron goes through three rigorous tests—physical, chemical and microscopic.

We break and twist test bars to make sure tensile strength and elongation conform to ASTM-A395-56T specs. We run a chemical analysis to assure the right base chemistry. Microscopic analysis tests for spheroid structure of graphite and completeness of ferritization.

You can get information covering each heat and all castings poured from it. Or we can make tests to your specs.

There's a big story on the Goulds Model 3195, available "off the shelf" in Ductile Iron. Ductile Iron compares to carbon steel in ductility, impact resistance and resistance to thermal shock. Costs less. Both pumping units and pump parts are highly interchangeable. It's available in Ductile-Ni-Resist when corrosion is a factor. Bulletin 725.1 can fill you in with all the details—dimensional interchangeability, bearing frame selection chart, pressure-temperature chart and other helpful information.

Just write Goulds Pumps, Inc., Dept. PR-61, Seneca Falls, New York.

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PIPE LINE INDUSTRY and The PIPE LINE CATALOG for the oil and gas pipe line industry.

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Some Changes Made

PETROLEUM REFINER readers now have more words in front of their name, this by the name change announced last month whereby PR became HP-PR, the HP standing for "Hydrocarbon Processing." That, of course, was the big change. But there are others two of which we'd like to point out from this Page 7 vantage spot.

• No. 1 you probably already have noticed. It's a more attractive, easier to grasp editorial contents page that, because of reader convenience, appears on the first page after you've flipped the cover. This change has resulted in a concentration on Page 5 of squibs giving readers a Quick Look at This Issue, another popular HP-PR feature.

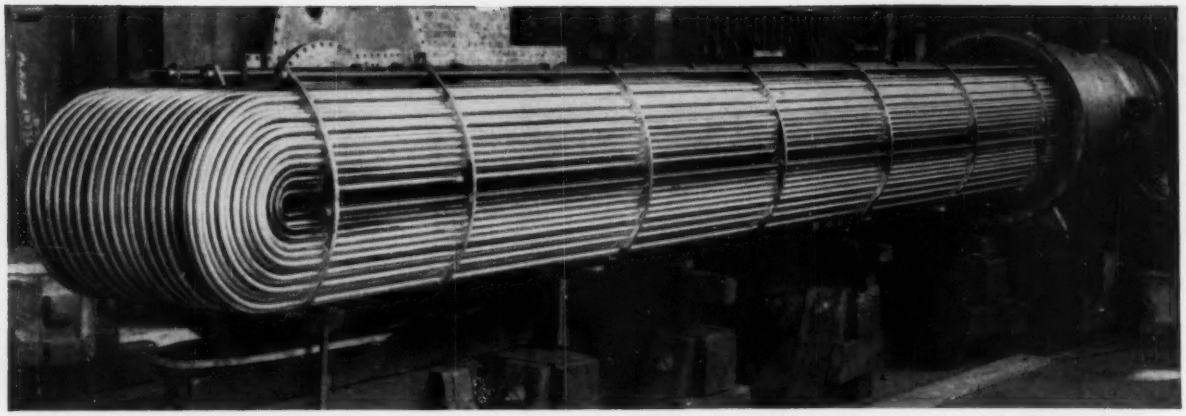
• Change No. 2 affects our What's Happening pages which heretofore have appeared each month in "the back of the book" immediately following the Who's Building Section. These pages have been moved forward (commence on Page 39 this month) which approximate spot they will occupy regularly. Besides their advanced position, readers will notice another change—the improved manner of presentation. This more thorough coverage of news and technical trends in HPI will be couched in a style pleasantly crisp and more readable. And there will be valuable interpretative reporting—always popular with readers when it's done skillfully and by experts. Traditional "straight news" will not be overlooked in this HP-PR modernization-expansion program.

We're Learning, Too!

LAST MONTH, Rollin Morse of Du Pont and Eugene Wall of Documentation, Inc., wrote about the new standards for information retrieval adopted by the AIChE (May HP-PR, pages 263-265). This month you'll see at the end of each feature article a list of keywords, which you may use in a conventional filing system, or better still in the new concept coordination system.

This is a new venture for our magazine and while you're learning concept coordination, we're also learning to do the indexing. We've found that there can be quite a bit of variation among indexers, even though each uses the same thesaurus. In fact, some of our editors are hardly on speaking terms because they can't agree on keyword terms. So, don't be surprised if this new way to index takes some time to understand and use; we editors are undergoing the same transformation. But after giving it some thought and study we believe you will find it quite worthwhile.

Another HP-PR Special Report on COSTS—always popular with readers—is in the cards for the July issue. Here are some of the subjects that will get intensive treatment: How to Estimate Plant General Costs, How to Distribute Manufacturing Costs, How to Estimate Operating Costs and How to Estimate Forced Draft Fan Costs. Some "most valuables" in that lineup!



This typical bundle of long-length Anaconda U-Bend tube is the heart of the modern feedwater heater. To get optimum capacity and efficiency—and a more economical and compact unit—designers have lengthened heaters instead of increasing shell diameter.

IN POWER PLANT FEEDWATER HEATERS

Anaconda long-length U-bend tubes offer higher efficiency and greater economy

Feedwater heaters play an important role in the efficient operation of a steam power station—and with today's more demanding conditions, the trend is to the use of long-length U-bend tube bundles in these higher pressure, higher temperature heat exchangers.

U-bend tube design reduces the number of tube joints to one-half. Each U-bend tube takes care of its own expansion stresses. There's no floating head—one less gasketed joint—all resulting in a more economical, more compact heater.

Now Anaconda makes heat exchanger tubes to 100 feet. This means U-bend tubes with legs approaching 50 feet are available. And the radius of the bend can be as small as 1½ times the diameter of the tube—or as great as 30 inches. Dual-gage tubes are made with extra wall thickness in the area of the bends, to cut cost and weight.

With a large family of alloys available for heat exchanger tubes, Anaconda can meet almost every requirement. From Arsenical Admiralty-439 to the cupro nickel group, long-length U-bend tubes can be made to handle a wide range of temperatures and pressures.

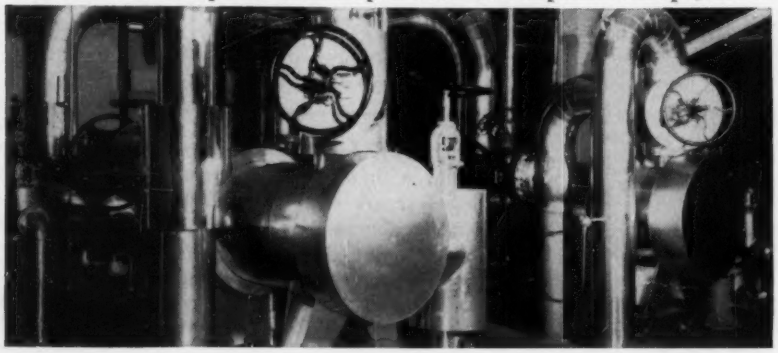
Specialists at Anaconda are constantly working with users and manufacturers of heat exchange equipment, helping to solve individual problems. This experience is available to you. For more detailed information on duplex tubes, dual-gage as well as U-bend tubes, see your Anaconda representative. Or write to: Anaconda American Brass Company, Buffalo Division, Buffalo 5, New York. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario. 6061

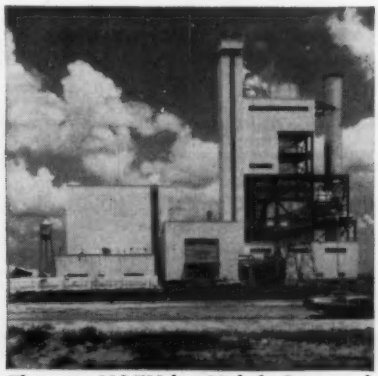
ANACONDA®

TUBES AND PLATES FOR CONDENSERS AND HEAT EXCHANGERS

Anaconda American Brass Company

Two of the three feedwater heaters at Nichols Station, using a total of 1692 Anaconda U-bend tubes of Arsenical Admiralty-439. Griscom-Russell Co., Massilon, Ohio, designed and built the heaters. U-bend bundles of longer, smaller diameter tubes provide a more effective surface, make possible more compact units. Heaters operate at 200 psi, 450°F.





The new 112,500-kw Nichols Station of Southwestern Public Service Co., Amarillo, Texas.

Quick Look at Industry...

Panning the Process and Product Scene . . .

New process for making phthalic acids from xylenes introduced by Cowles Chemical and Catalytic Construction. Process is "capable of making any of phthalic acid products from individual xylene isomers" . . . Cities Service up with two new chemicals in pilot plant quantities, 1,3 cyclo-octadiene and 1,5,9 cyclododecatriene . . . Goodyear planning use of polyesters and polyolefins in tire cords . . . Amoco starts mixing chemical substances by electrostatc field, eliminating moving equipment such as impellers or circulating pumps . . . New butyl synthetic rubber with high ozone resistance developed by Esso R & E.

Shell Chemical may be ready to go commercial with foamed epoxy resins . . . Nalco Chemical to manufacture TEL and TML in new Freeport, Texas, plant . . . Seiberling rubber up with new polyvinyl dichloride sheet serviceable at 215° F . . . Dow and Union Carbide may be making duplicate ethylene copolymers, with cross licensing possible result . . . Spencer Chemical announces new polyethylene latex made with exclusive process.

New Route to Acetylene? . . .

Delhi-Taylor and Hydrocarbon Research pool patents and technology for "superior acetylene process." Both companies have been doing pilot plant studies on hydrocarbon-based acetylene for several years. Result: Highly purified product with higher yield than existing processes, and reduced oxygen consumption. Hydrocarbons are mixed cold with oxygen—then preheated together before reaction, using high velocities, low residence times.

Attacks Raiding of Plant-Wide Unions . . .

National Labor Relations Board receives statement from National Petroleum Association urging reaffirmation of NLRB decision to prevent craft unions from breaking up plant-wide bargaining units. In February case involving American Cyanamid, board decided to prevent indiscriminate raiding of plant-wide unions.

The Soviet Oil Glut . . .

U.S.S.R. claims it will be able to export 2 million bpd of crude oil within next decade, while construction of refineries is slated to increase 240% under current 7-year plan. About 1/5 of all Soviet production is exported, with Europe main target area. In period from 1956-60, crude production jumped to 2.96 million bpd.

Sizing Up Sulfur and Sodium . . .

Metallic sodium for sulfur removal? U.S.I. is pushing the process, claiming small coke-oven aromatic producers can compete with makers of petroleum BTX by treating coke-oven light oils with metallic sodium. Result: Reduction of thiophene content to less than 1 ppm at 0.8 to 1.5¢ a gallon. Process also works on naphthalene for 0.6¢ per pound of product. Capitalization costs are low.

Trustbusters Swing at Conoco . . .

Justice Department charges Continental Oil with illegal merger for purchase of Malco Refineries, Roswell, N.M., in 1959. Complaint asks

that Conoco be required to set up independent, competing firm and transfer to it all assets and business gained at time of acquisition. Conoco has emphatically denied charge of monopoly.

A Problem With Polyolefins . . .

Polyolefin marketers having problem as capacity grows rapidly—predicted to hit 2.6 billion pounds by 1964. Thus, annual sales must increase about 900 million pounds a year. Added problem: Expected overseas competition which could chop present 300 million pounds exported annually. With exports cut off, all stops will be pulled to unload domestic production.

A Squint at the Future . . .

LPG demand in petrochemical industry is soaring, expected to hit slightly over 2.1 billion gallons this year . . . Research on new combustion technique underway at Ford Motor—could lead to 50% savings in gasoline consumption in next few years . . . Look for U.S. ethylene capacity to soar from present 6 billion pounds a year to 10 billion by 1970, say Kellogg authorities . . . IPAA foresees 1.2% increase in demand for all oils this year—up 114,000 bpd from 1960.

Agency to Watch Automation . . .

Federal Government sets up Office of Automation and Manpower to study manpower displacement caused by technological advances. Ultimate goal: Finding cures for resulting unemployment. Labor Secretary Goldberg's view of automation: "If management must automate, and I believe it must, it must assume a larger role than it has in the past to ease the transition for human beings . . . And labor must meet management halfway . . . by abandoning restrictive practices."

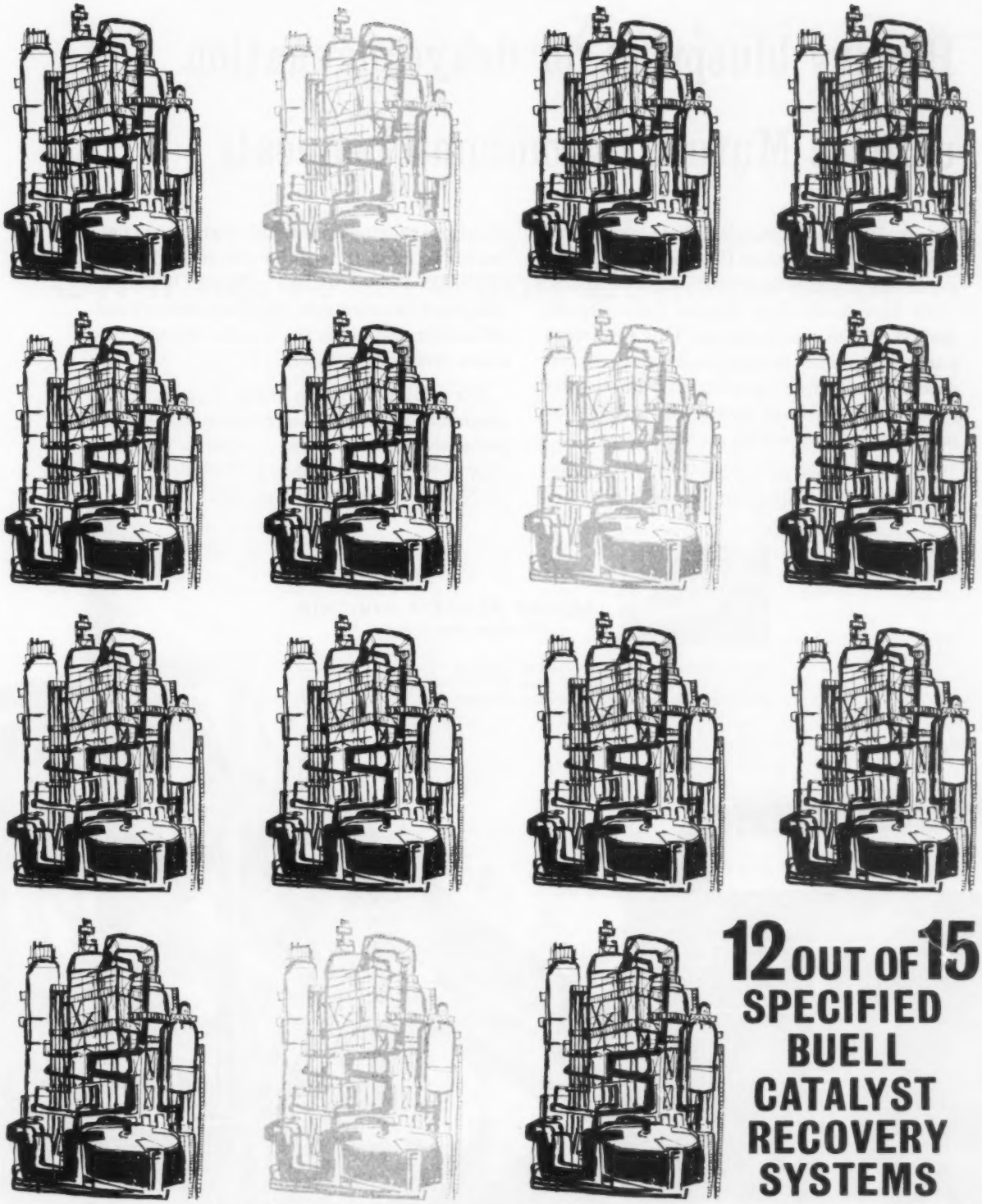
Quick Look Around the World . . .

Monsanto planning first major chemical complex designed from ground up for computer control . . . Interior Department's new Helium Research Center set up at Amarillo, Texas . . . Six key federal government agencies line up solidly in favor of national fuels study . . . National Association of Manufacturers and Commerce Department square off for battle over proposed merger notification bill . . . Interior Department pushing major research projects on coal-based gas and liquid fuels . . . Italian senator attacks use of TML in gasoline, charging fumes are toxic and dangerous. Counter claim by oil companies: Skin penatrability is only 1/10 that of TEL.

Several key ethylene producers plan to operate on C-5 and heavier feeds in spite of general trend to use light feedstocks for cracking to ethylene. Reason: It's too expensive to convert C-5+ streams to high-octane gasoline . . . Sunray claims better product quality coming from "partially unattended" gas processing plants—also says shutdown time has been inexpensive . . . HDA hydrodealkylation process licensed by Esso R & E, Atlantic Refining and Hydrocarbon Research to include patent rights and know-how of all three companies. Arrangement extends scope of process announced in March by Atlantic and Hydrocarbon.

For More News and Trends . . .

For expanded treatment of trends and news appearing in "Quick Look at Industry," plus many other items of interest, don't miss the feature "What's Happening in HPI," beginning on page 39.



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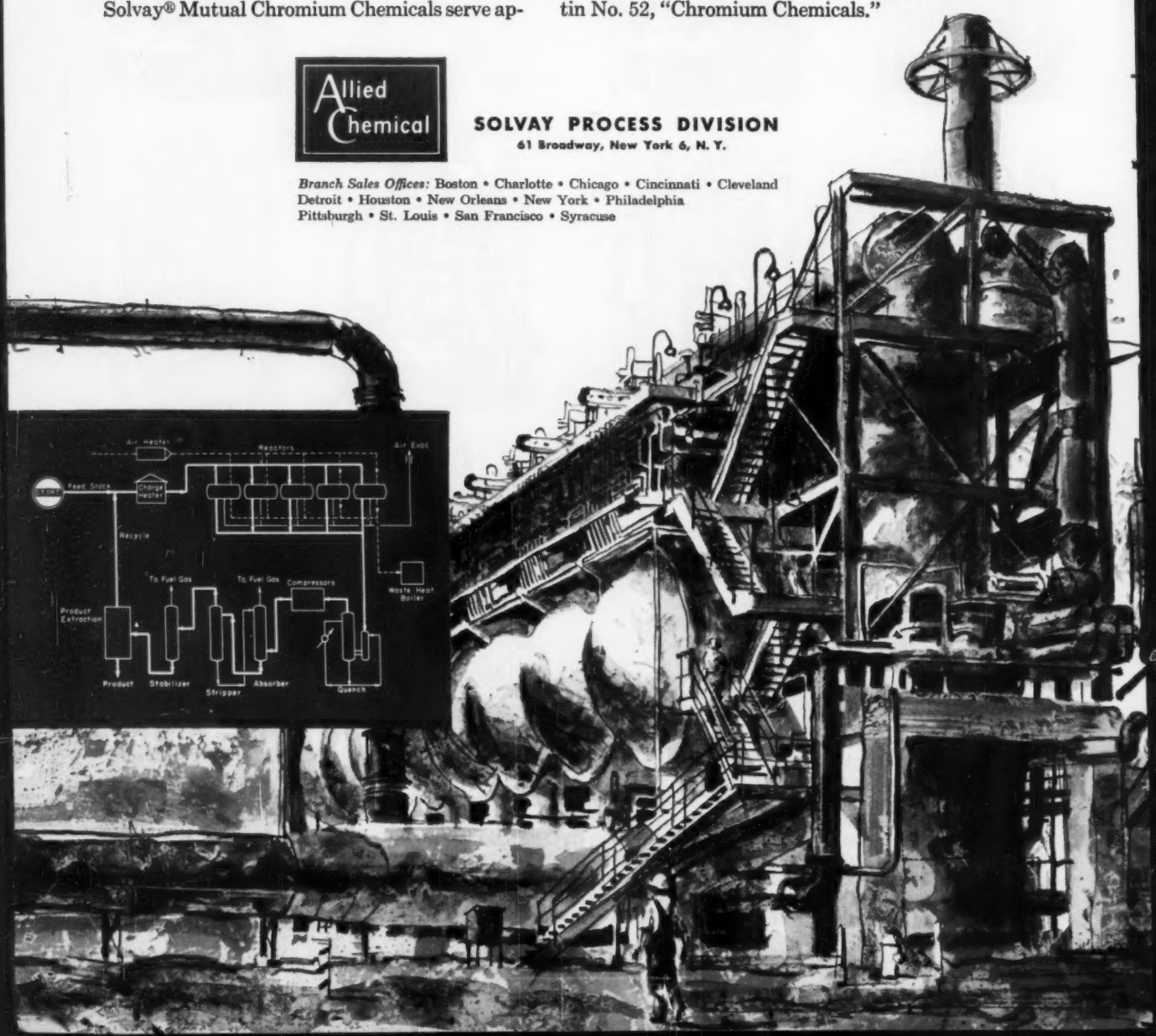


Offering: A Common Denominator

CHEMICAL ENGINEER Jim Sparks leaned back in his chair, frowned at his office roommate, and said, "You know Phil, this duplication of effort that's been going into some of our design problems is beginning to bug me. I was talking to Joe Brown over in R & E yesterday, and darned if they didn't have a whole crew working on some aspects of the same distillation problem we tackled on that Jonesboro job in January."

Phil smiled back at Jim, and with a sly twinkle in his eye replied, "Yeah, sometimes it seems to me we're redesigning the wheel six times a week around here." He picked up a pencil and toyed with it thoughtfully. "Jim, we have a real problem in this business of finding what's already been done on a given subject. I was reading just yesterday that no less than 10 percent of the nation's $12.5 billion R & D budget goes for pointless duplication of effort.

Jim scratched his head and eyed the slide rule on his desk. "Boy, that's a lot of dough! Wonder what our share of that billion-dollar pie is?"

Phil grinned and muttered, a little sarcastically, "Well you can bet it's being paid for somewhere, and some of it is coming out of your pocket and mine. Jim replied, "Right, but the company is being squeezed in the cost problem too. I'm sure nothing would make our management happier than an efficient, easy-to-use way to retrieve info—one each engineer could use at his own desk. I saw a comment somewhere by Henry Longnecker, head of R & E at the drug firm Smith, Kline and French. He says the biggest single obstacle to creating an effective information service is that people have become so used to living with the information problem that they've stopped looking for ways to solve it."

The Real Problem. Phil leaned forward, looking intently at Jim. "Well, Longnecker is right to some degree, of course, but maybe the real problem is not that people have quit looking, but that they're looking only for a way to suit their own particular needs at a given time. What I'd like to see is a card file system of some sort that I could keep right here on this desk—one that would be suitable for cross indexing subjects and ideas from the reports we see, plus all the trade journals. If I had something like this, and the boys over in R & E had the same setup, we would avoid a lot of duplicated effort. And, if we had something like this on an industry-wide basis, we could trim plenty off that $12 billion loss in short order."

Jim nodded his head enthusiastically. "Right, Phil! And if we had some kind of common denominator to go along with this—a technical thesaurus geared to our industry—we could eliminate the semantics barrier. This way, the R & E boys would be working with the same retrieval tools we use."

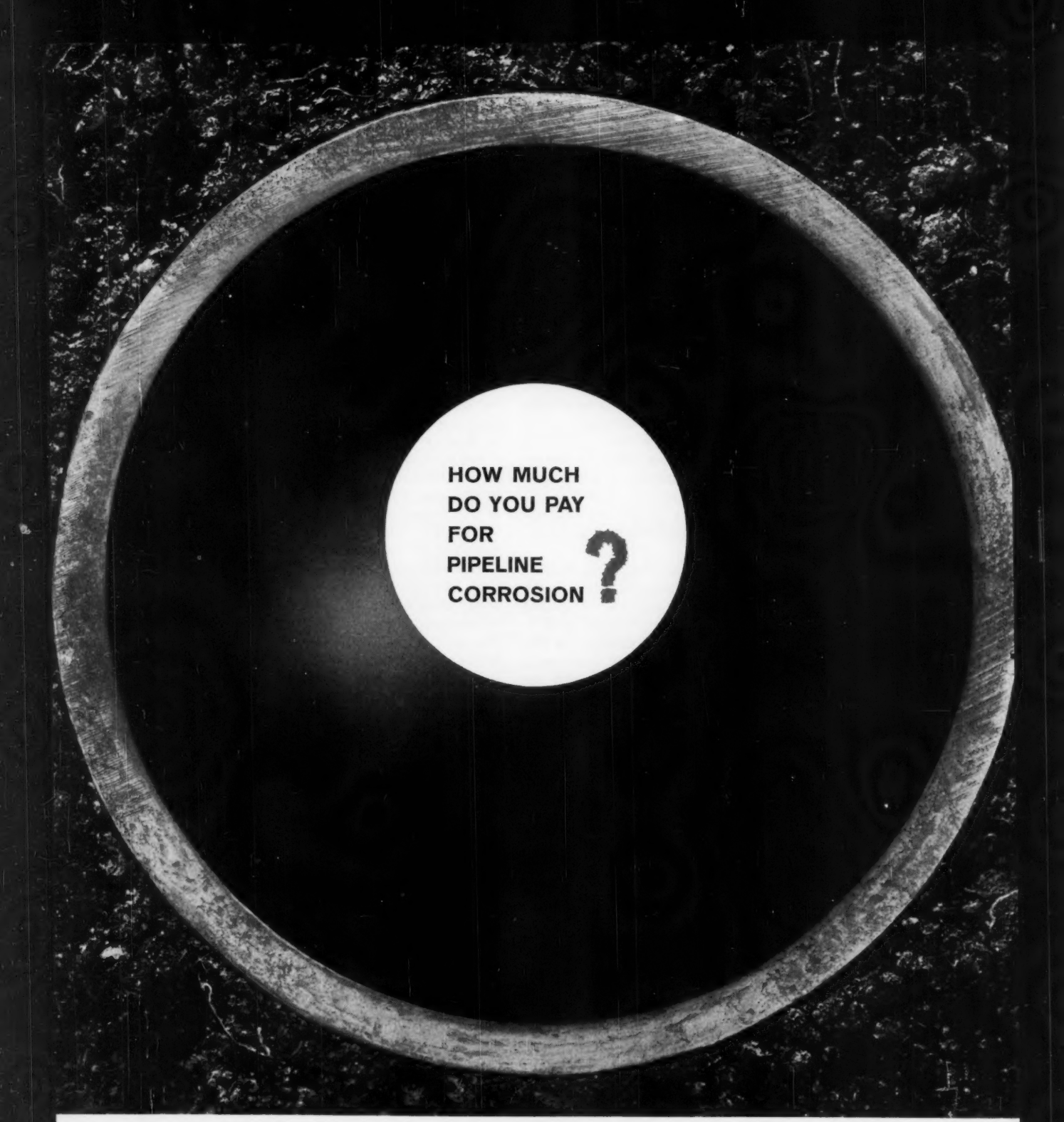
Phil replied, "That's a good point. A reference book like that would be a big help, and a darn site better than wading through hundreds of thousands of unrelated terms. In fact, investigation has shown that the vocabulary of any one field of technology is limited to about 5,000 terms. Not only that, Jim, the vocabulary of all technologies is limited to about 20,000 terms, and all human knowledge could be expressed in 40,000 terms."

Jim picked up his pencil and turned back to his desk. "Well, Phil, I surely hope somebody comes up with an answer soon. It would make our work easier, save the industry millions, and maybe in the process put some more of that long green in our pockets."

In Every Mind. This conversation could have taken place in almost any operating company or construction firm in the HPI. And even when the subject doesn't come up in shop talk, it is certainly in the minds of every engineer who must do research or applied technological work.

Those who have been disposed to do something about the problem have coined the term "Information Retrieval." Encompassed in this term is all the hopes and dreams of every HPI engineer who has been in the middle of a complex problem, only to pause and ask the inevitable question—"Has this been done before? If so, how can I find out where, by whom, what was their technique, how did they finally solve the problem?" Too many times these questions have been left open—unresolved. Too many times the questioner simply has had to shrug his shoulders, shake his head, pick up his pencil, and go back to work on those equations—probably already solved by R & E or by the XYZ Co.

Perhaps the problem is best summed up in words uttered 16 years ago by Vannevar Bush, wartime head of the Office of Scientific Research and Development. Said Bush: "The summation of human experience is being expanded at a prodigious rate,



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That's why many refiners and pipeline operators add 1 to 3 pounds of Du Pont RP-2 corrosion inhibitor to every 1,000 barrels of their gasoline and other distillates. It's an inexpensive way to cut these expensive costs.

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but the means we use for threading through the consequent maze to the momentarily important problem is the same as was used in the days of square-rigged ships . . . the modern great library is not generally consulted; it is nibbled at by a few."

In the 16 years since Bush spoke, some people have been worried enough about the information-retrieval problem to seek a solution. These people have been faced with the seemingly overwhelming job of finding a system that will be all things to all people. Swirling around in their heads have been a myriad of terms and concepts—abstracts, cross indexes, syntax, lexicography, concept coordination, and so on, down the list.

A Workable Approach. Yet, out of this morass of apparent confusion has come a new, workable approach to retrieving information. It is an easy-to-use system developed by AIChE's Subcommittee on Standards of Information Handling, discussed in "New Information Retrieval Standards," May 1961 issue HYDROCARBON PROCESSING & PETROLEUM REFINER, page 263. In cooperation with this system, you will find at the end of each feature article in this and succeeding issues, a list of "keywords" for use in setting up one's own information retrieval file.

We hope that eventually all HPI companies and engineers will use this valuable technique. Think what it will mean for you to have at your fingertips a complete, categorized file on the most significant literature available in your field—an index specialized to your needs and interest. Here at last is a card file system that is comprehensive, yet not cumbersome, and which requires no machine processing. The only tools needed are your pencil, 3 x 5 card file, and an inexpensive thesaurus to be published this month by AIChE. This thesaureus is based on an earlier version developed by E. I. du Pont de Nemours & Co. It contains 7,000 to 8,000 words accumulated over a ten-year period from chemical engineering reports of Du Pont's Engineering Department. These words provide a "common denominator," **standardized vocabulary** that Jim, Phil, and all of us can use.

This retrieval technique is going to save you some headaches. It is going to save your company time and money. Perhaps most important, it will help you do your job better—a real shot in the arm for your professional status.

Now sit back, relax, and enjoy your June REFINER. And don't forget to index the articles in your new Information Retrieval File. By the way, don't worry about Jim and Phil. We're sending them a copy of this editorial.

We Change Our Name

PETROLEUM REFINER last month announced a change in name, the second change since the magazine was established as "Refiner & Natural Gasoline Manufacturer" back in 1922. One change came in 1942 or 20 years after the magazine, the first ever to cover a specialized function of the petroleum industry, initially came from the press.

So the new name, HYDROCARBON PROCESSING & PETROLEUM REFINER, announced in a hard-to-miss flysheet inserted in the May issue, comes after a second almost identical period.

The thought behind this name change reflects the publisher's and the editor's views of the enlarged and enlarging field which we cover. Ever since its establishment HP-PR has been the leading periodical in its field which is oil, gas and petrochemical processing now known as HPI or the hydrocarbon processing industry.

Right here it might be interesting to note that just about a year ago—in our April 1960 issue, to be exact—"hydrocarbon processing industry," as a term, was introduced on these pages by the chairman of our editorial committee, Dr. John J. McKetta. Because of its appropriateness, it caught on promptly—so much so that in August of last year we changed our subtitle from "Oil, Gas and Petrochemical Processing" to "For the Hydrocarbon Processing Industry." Since then HPI has become quite a familiar and meaningful term.

Certainly the new name, as stated in May, more nearly identifies the scope of the magazine.

Our editors, of course, will continue to cover every phase of all significant developments in HPI. Such has been the policy of PR over all the past years and it surely will be the prime objective of HP-PR.

American Optimism

WE AMERICANS are optimistic about the future. However, our optimism rests on the premise that our future will be the outcome of personal strivings.

It is true that many of us Americans doubt whether world situations are improving, a fact probably due to the never-questioned effects of scientific technology bestowed upon us day by day.

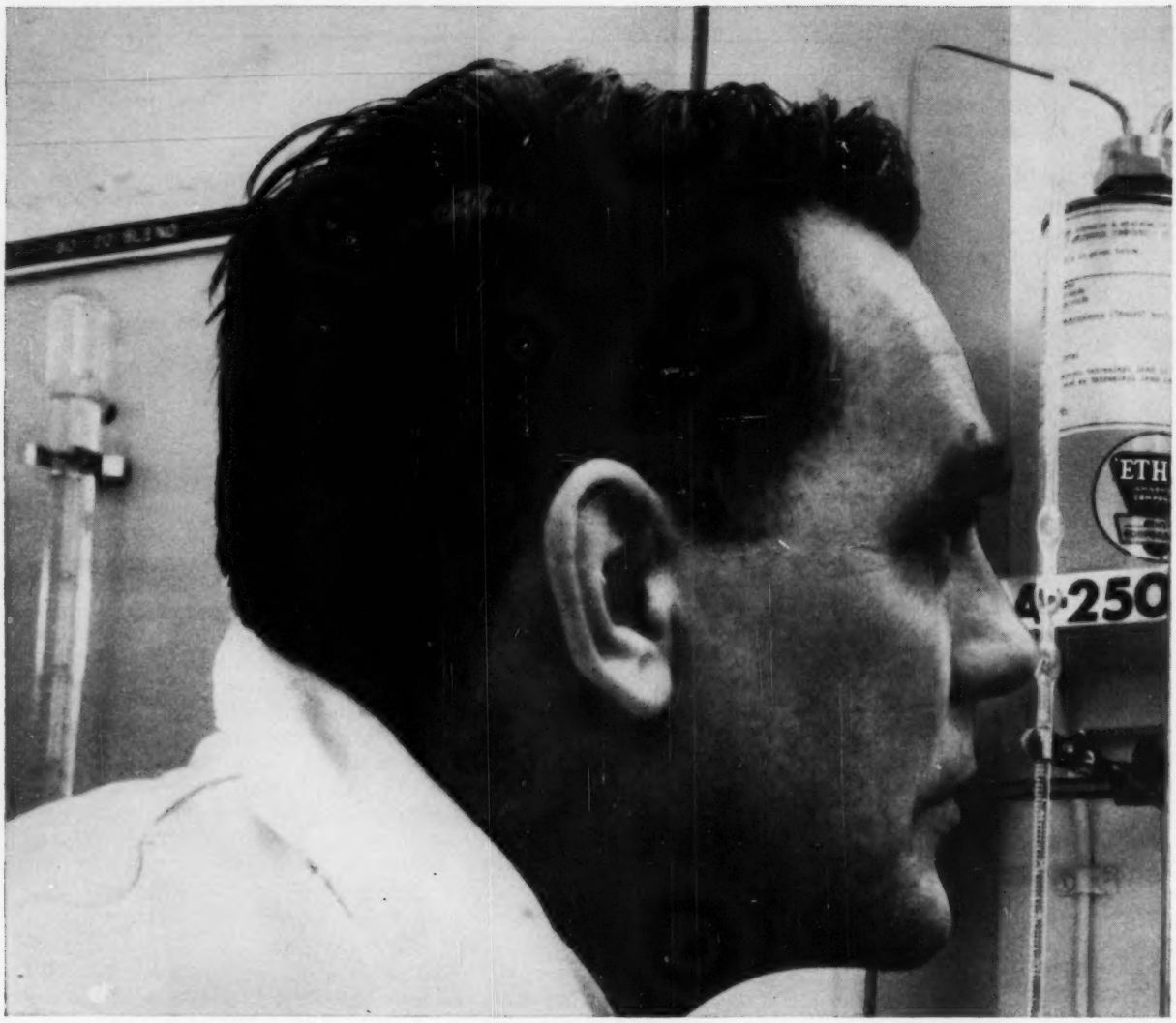
Also, when talk of the future arises, it usually brings out our previous attempts to convince ourselves that one day the world will take a turn for the better.

In addition, if we are to foresee the coming years, we should not forget the events of the past. Certainly, "history repeats itself."

Robert L. Heilbroner, in "The Impasse of American Optimism," Winter, 1959-60 edition of *The American Scholar,* says, "We need only reflect on the course of European disillusion to recognize that our different expectations toward the future reflect experiences of the past."

None the less, American foresight likely will be better than that found in other parts of the world. We live in a land of plenty, one untorn by severe world war.

We are a nation of optimists.



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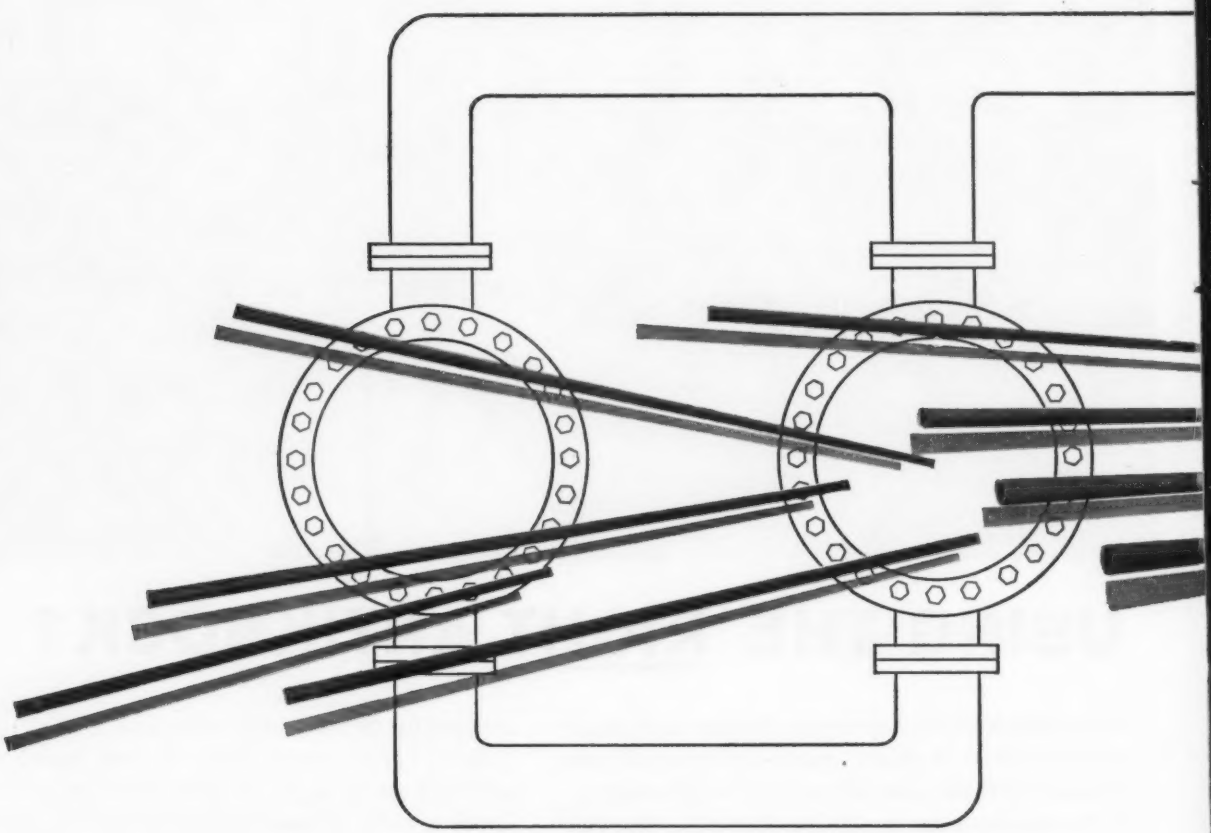

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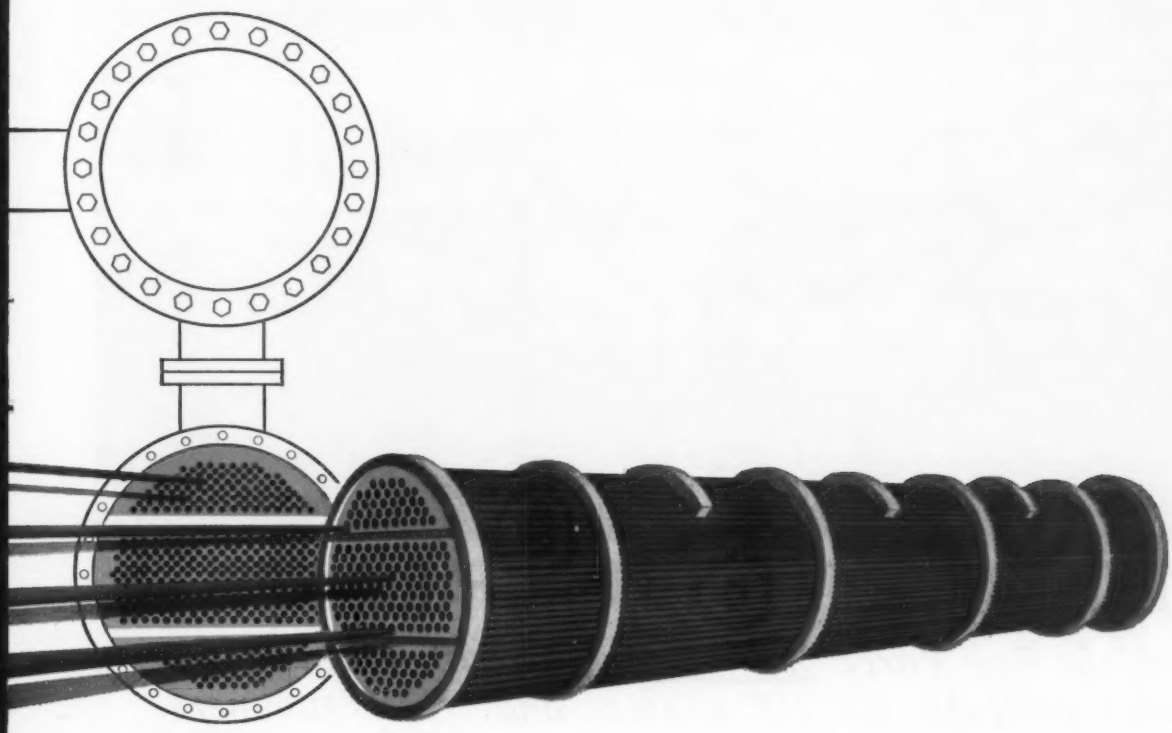

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INDUSTRY IQ QUIZ

Test your industrial IQ with this quiz on the current issue of HYDROCARBON PROCESSING & PETROLEUM REFINER

1. Retirement. Of all the workers in the United States currently in the 35-45 age group, how many will live to the retirement age of 65? (a) 60 out of 100, (b) 70 out of 100, (c) 90 out of 100.

2. Hydrocracking. So far, what is the highest endpoint material hydrocracked in commercial operation? (1) 600-700°F, (2) 700-800°F, (3) 800-900° F.

3. Knock-Out Drums. Vertical knock-out drums are used instead of horizontal drums when the liquid separated is: (a) less than 1 gpm, (b) more than 1 gpm, (c) less than 5 gpm, (d) more than 5 gpm.

4. TEMA Standards. The new fourth edition of TEMA standards has eliminated the necessity for specifying exchangers by class such as TEMA C or TEMA R. True or False?

5. Heat Exchanger Design. When designing heat exchangers, the maximum allowable pressure drop and the heat duty in Btuh are known. True or False?

6. Costs. What is the erected cost per barrel for a 30,000-barrel, 50-psi sphere? (a) $5.00, (b) $5.43, (c) $6.13.

7. Crude Desalting. Crude desalting can give many credits when installed on crude processing units. The biggest single saving depends on whether more crude throughput is required or not. Pick the item in each case which you think will be the biggest savings factor: (1) for fixed crude throughput and (2) for increased throughput.

a. Fuel savings
b. Reduced Maintenance
c. Cooling Water Savings
d. Reduced tank cleaning
e. Increased tank capacity.

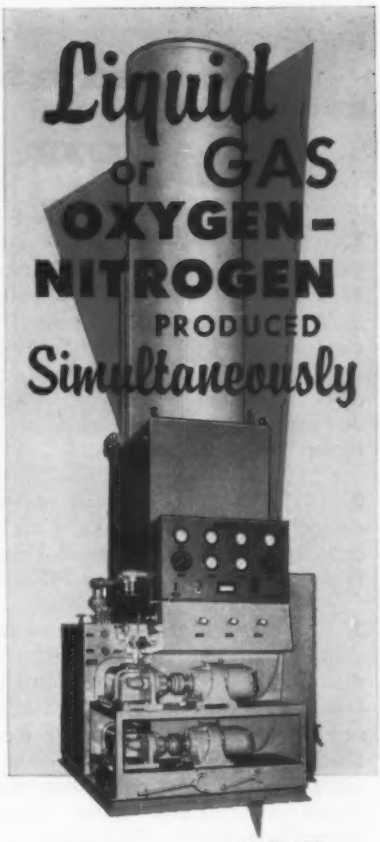
8. Rigging. Which is used most for rigging in today's process plants? (a) chain hoists, (b) manila rope.

9. Recycle Systems. More complex recycle systems can be easily handled by breaking them down into smaller systems around each separation step. True or False?

10. Phenol Production Costs. Of the four commercial phenol processes, which has the highest materials cost? (1) cumene, (2) chlorination, (3) Raschig, (4) sulfonation.

11. Trade Secrets. The laws of trade secrets and proprietary rights have no control over any specialized knowledge an engineer gets while with a given company, unless specifically provided by contract. True or False?

Answers on Next Page . . .



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INDUSTRY QUIZ

(Answers to Quiz on Page 21)

1. (c). According to statistical mortality rates established by a leading life insurance company, 90 will make it. Those who make it to 65, say the statistics, will live until 78. To learn more about your life's expectancy and other interesting aspects of health and old age, be sure to see "How to Retire," **Page 127.**

2. (3). If you picked one of the others, you need to be brought up to date by reading "Now Revise Those Hydrocracking Costs," **Page 147.**

3. (a). Vertical knock-out drums are used for light-mist entrainment (less than 1 gpm of liquid separated). Horizontal drums are used for heavy vapor-liquid separations (greater than 1 gpm of liquid separated). For the big picture of designing knock-out drums, see "Check These Points When Designing Knock-Out Drums," **Page 155.**

4. False. The fourth edition expressly states: "TEMA R and TEMA C are meaningful specifications. TEMA alone is not." For the true picture of TEMA standards, see "New TEMA Standards Compared to Old," **Page 157.**

5. True. Normally the maximum allowable pressure drop and the heat duty are known. The problem is to find the minimum size of the heat exchanger that would be suitable for this specified duty and pressure drop. To solve your heat exchanger design problems, see "Graphs Cut Exchanger Design Time," **Page 165.**

6. (b). There's more data on spheres and double-deck floating roof tanks in "Equipment Cost Data File—(Part 3)," **Page 173.**

7. (1) b, (2) e. For all the details, see "Check This Payout on Crude Desalting," **Page 175.**

8. (a) and (b). There is considerable discussion as to which is most used, chain hoists or manila rope. In fact, the controversy would be hard to settle because both are indispensable. For the details, see "Rigging Techniques for Process Plants," **Page 183.**

9. True. Most chemical processes can be handled by the method shown in "Use Fractions for Recycle Balances —(Part 2)," **Page 189.**

10. Cumene. However, under certain conditions, all processes are competitive. For just how they fit into the overall plan, turn to "Processes and Prospects for Phenol," **Page 193.**

11. False. There is both a moral and legal duty not to reveal certain types of information you get through your employment, with or without a written contract. For a discussion of this and some cases in point, be sure to see "How Much of Your Knowledge is Yours," **Page 209.**

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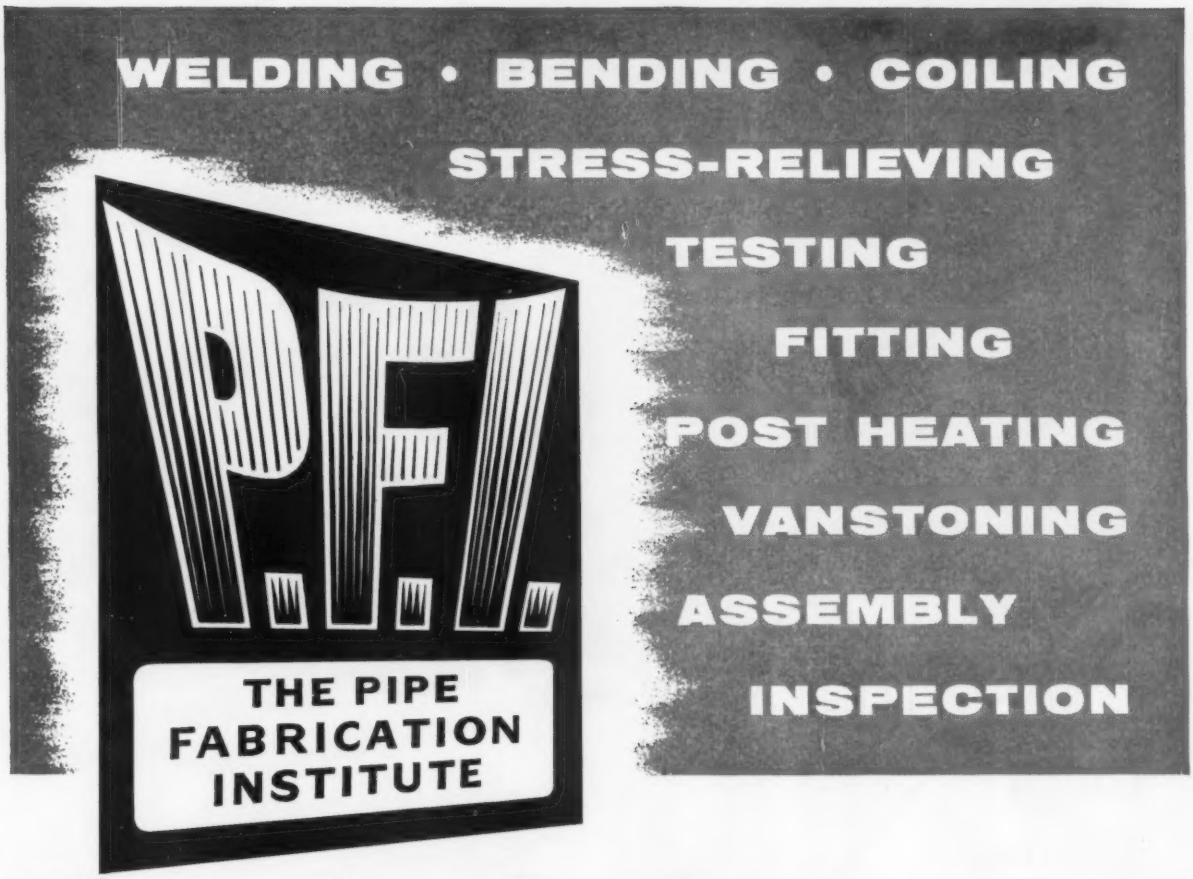

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Sodium Sulfate, Anhydrous
Trisodium Phosphate
Tetrasodium Pyrophosphate (TSPP)
Sodium Tripolyphosphate

ACIDIZING
Hydrochloric (Muriatic) Acid
Hydrofluoric Acid
Sodium Bifluoride

MUD CONDITIONING
Sodium Silicate
Disodium Phosphate
Trisodium Phosphate
Tetrasodium Pyrophosphate (TSPP)
Sodium Tripolyphosphate
Pyrites Cinders

GREASE MAKING
Aluminum Sulfate

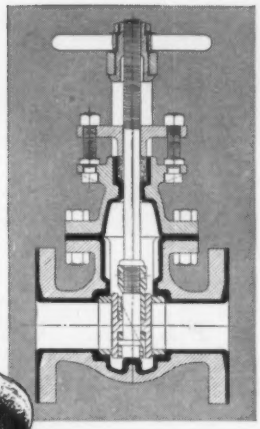
ACID TREATING
Sulfuric Acid
Sodium Silicate
Other heavy chemicals, catalysts, addition agents, inhibitors and special "tailor-made" chemicals.

Baker & Adamson® Laboratory Reagents

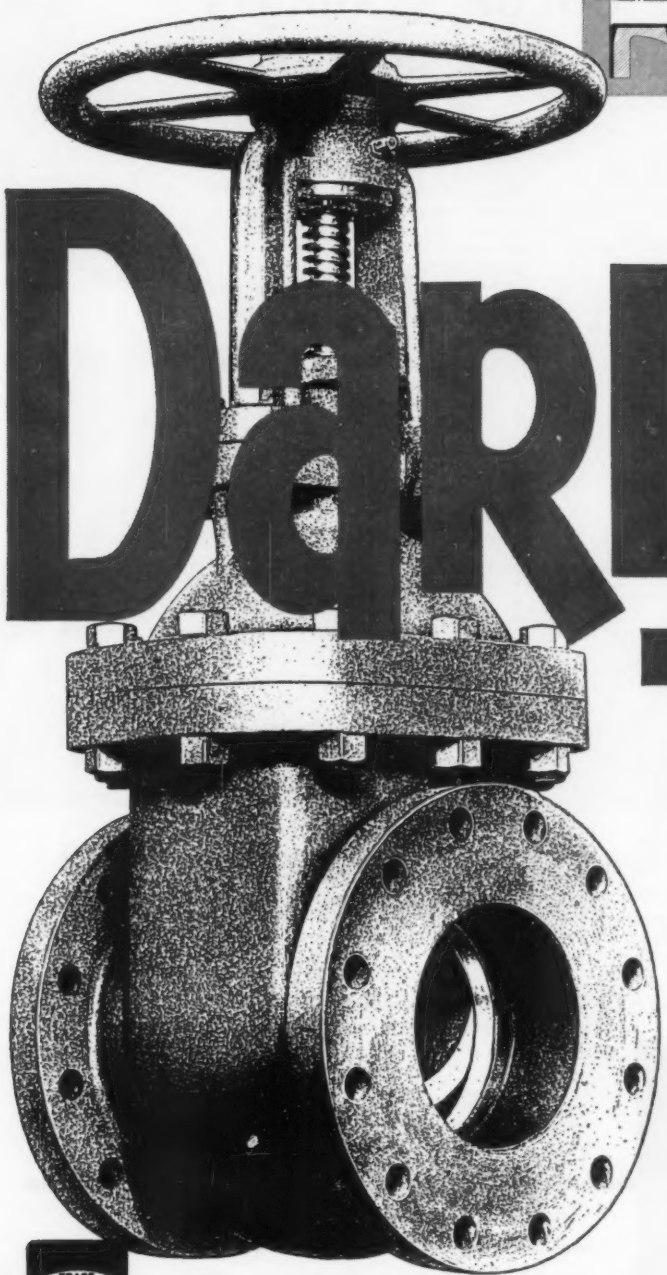
Basic to America's Progress

Allied Chemical

GENERAL CHEMICAL DIVISION
40 Rector Street, New York 6, N. Y.



Darling rubber-lined (heavy lines) iron body gate valves with special alloy working parts provide trouble-free operation in many corrosive and abrasive services.



YOU CAN DEPEND ON

Darling

Darling rubber-lined iron body gate valves eliminate the need for expensive special alloy valves in many different applications.

The hard rubber lining on bodies and bonnets provides high resistance to corrosion and abrasion in services up to 180° F. and working pressures up to 150 lbs. The revolving double disc parallel seat and wedge construction minimizes friction, avoids wear concentrations, and automatically compensates for any valve seat deflection. *You can depend on Darling* rubber-lined iron body gate valves for maximum efficiency at minimum cost.

Darling rubber-lined iron body gate valves in rising stem, cylinder or motor operated, and quick-opening types, as well as rubber-lined iron body check valves, are available in sizes from 2″ to 24″. Write, wire or phone for bulletins.

DARLING VALVE & MANUFACTURING COMPANY

Williamsport 31, Pa.

Sandilands Valve Manufacturing Co., Ltd., Galt 19, Ontario, Canada
Vannes Darling-France, 23 rue du Commandant Mouchotte, St. Mandé, France

TRADE DARLING MARK

GATE • BUTTERFLY • CHECK • SPECIAL VALVES • FIRE HYDRANTS

For more data on advertised products, use cards, last page.

TOLAD®
FUEL ADDITIVE

a NEW Tretolite product

IMPROVES FUEL "COLOR STABILITY" AND REDUCES RESIDUE AT LOWER COST

TOLAD* Fuel Additive formulations have been thoroughly tested in Tretolite laboratories and spot commercial applications for over two years. In test after test, TOLAD has improved fuel oil color stability, dispersed insoluble residue, and reduced sludging characteristics, and has done so at a lower cost than the commercial additive which it replaced.

FURNACE FUELS

TOLAD Fuel Additive enhances the salability of domestic furnace fuels in storage by inhibiting the formation of insoluble residue, preventing the formation of sludge and retarding color degradation.

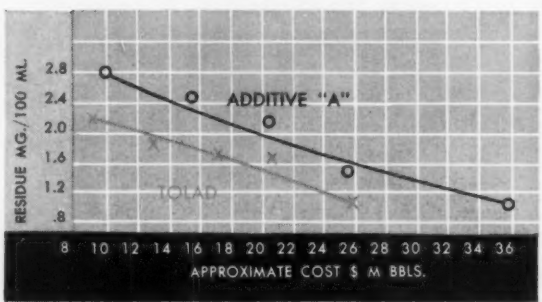
DIESEL FUELS

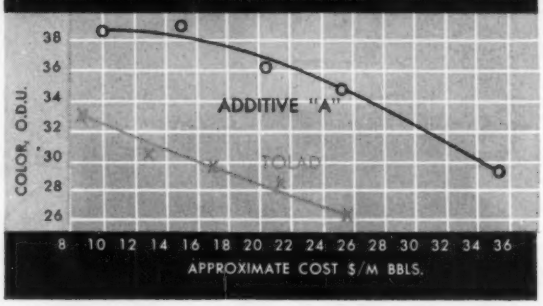
Diesel fuel sludge is the prime cause of plugging in fuel filters, injection systems and burner nozzles. TOLAD Fuel Additive improves the performance characteristics of diesel fuels by preventing the formation of sludge.

Whenever fuel deterioration is caused by long storage periods, TOLAD additive will *economically* help to maintain fuel quality and salability.

For complete information, ask your Tretolite refinery service engineer, or write to

The graphs illustrate TOLAD'S ability to improve color and residue characteristics of fuel in storage more economically. In these tests, a commercial furnace oil was subjected to a 12 week 110°F oven storage test. TOLAD was added to one sample, another commercial additive to the other. At every reading, TOLAD effected the desired color or residue characteristics at a lower per-barrel-cost.





*Registered Trademark, Petrolite Corporation

FA-60-2

PETROLITE CORPORATION

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200 South Puente Street, Brea, California

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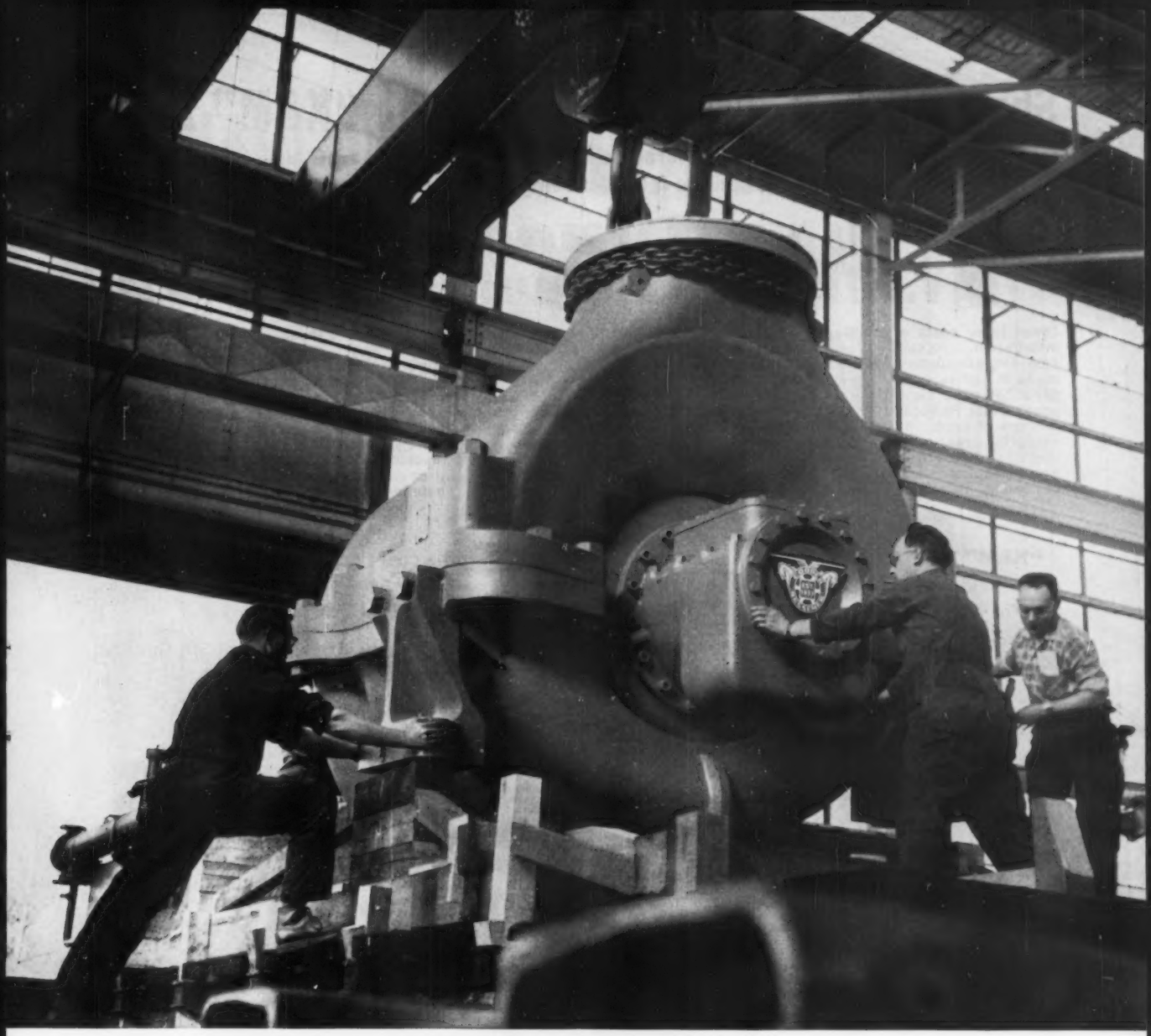


Another Cooper-Bessemer centrifugal goes to work

Here's proof of compressor economy

When your plans call for centrifugal compressors, it will pay you to be guided by the experience of others. Take a tip from the *repeat order* record of Cooper-Bessemer centrifugals as a sure sign of *cost-saving performance.*

The Cooper-Bessemer centrifugal shown here is being shipped to a chemical manufacturer for big volume compression. They *know* how reliable C-B centrifugals really are. Another unit has been operating there 'round-the-clock for two years, as part of a process, where constant availability is a *must.*

Repeat orders for Cooper-Bessemer centrifugal compressors have come time and again from many progressive companies.

Many features account for the stamina and dependability of Cooper-Bessemer centrifugal compressors—such as their rugged all-welded impellers, and unique shaft sealing. Find out how they can pay off for *you.* Call our nearest office or write . . .

Cooper Bessemer

GENERAL OFFICES: MOUNT VERNON, OHIO

COMPRESSORS: RECIPROCATING AND CENTRIFUGAL
ENGINES: GAS · DIESEL · GAS-DIESEL
JET-POWERED GAS TURBINES

Shave thermal insulation costs with "K&M" Zebra*

***A low, medium, and high temperature multi-layer, sectional-type pipe insulation, of calcium-silicate-asbestos bonded felts, for temperatures ranging from 200 F to 1200 F.**

1

Lower labor costs of installation. "K&M" ZEBRA Pipe Insulation, made in half-sections thru 24" pipe size, goes on fast. Reduces number of joints. Its smooth, practically dust-free surface won't penetrate skin, or cause irritations.

2

Reduced breakage and wastage costs during installation. "K&M" ZEBRA Pipe Insulation has a deflection at breaking point 2 to 4 times that of ordinary thermal insulation. It's easy to cut and fit on the job. Saves on material costs.

3

Minimum interruption to your production schedule. Your production goes back to normal faster . . . with the swift, efficient installation of "K&M" ZEBRA Pipe Insulation. Delays and downtime are minimum. Production costs go down.

4

Little or no upkeep costs. "K&M" ZEBRA Pipe Insulation requires no coddling on the job. Won't crack or warp from shock or heat. Withstands intense vibration without cracking or abrading. Its service life is almost maintenance-free.

5

Maximum re-usability. You can dismantle, re-apply, and re-use "K&M" ZEBRA Pipe Insulation on other applications. Thus, you can save on the costs of new thermal insulating materials . . . profit from longer service of "K&M" ZEBRA.

"K&M" ZEBRA® Pipe Insulation aids you in the fight against the cost-price squeeze and downward-spiraling profit margins. "K&M" offers you a complete line of quality asbestos insulations . . . blocks, spray-type materials, and cements . . . plus high-grade asbestos textiles.

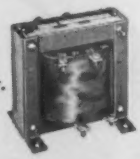
For more information, write to: Keasbey & Mattison Company, Ambler, Pa., Dept. I-261. In Canada, write to: Atlas Asbestos Company, Limited, 5600 Hochelaga Street, Montreal 5, P.Q.

SQUARE D SPIN TOP® ENCLOSURE NOW MORE VERSATILE THAN EVER!

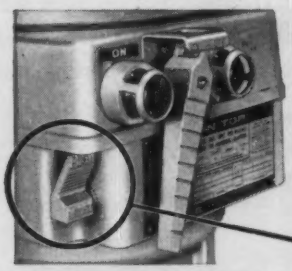
DAMAGE-RESISTING Acme threads. If you've struggled with "banged-up" threads, you'll appreciate this feature. It's always a breeze to put on and take off tanks for installation, inspection or maintenance.

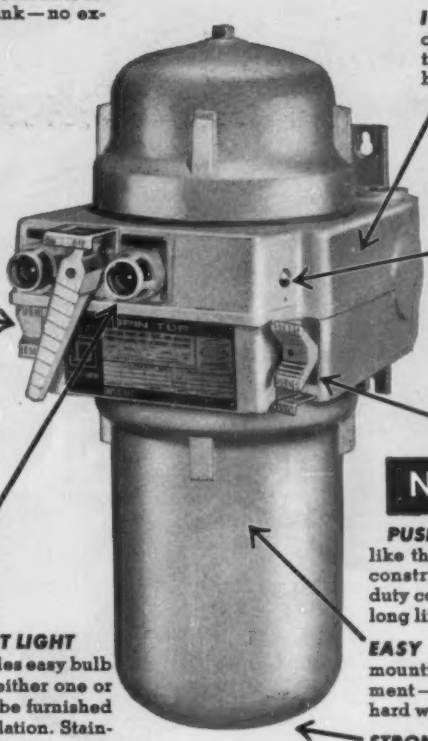
FULL WEATHER PROTECTION • Male threads on collar engage female threads on tank—no external threads to be damaged.

NEW! ***CONTROL TRANSFORMER*** can be mounted in collar. No special-length tanks required.



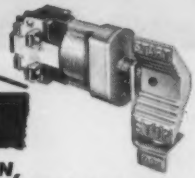
INCREASED WIRING SPACE • Four conduit openings standard, with through-feed conduit entrances for horizontal tap-offs optional.



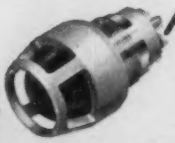


NEW! ***SELECTOR SWITCH*** is made in one piece, installs simply by threading into opening provided in enclosure. One-piece construction permits pre-testing before shipment.

NEW! ***RECESSED CONTROL STATIONS*** like the reset button are out of the way, have no protrusion to break or bend accidentally.



NEW! ***PUSHBUTTON,*** like the selector switch, features one-piece construction for easy installation. Heavy-duty contacts and rugged mechanism assure long life.



NEW! ***BRILLIANT PILOT LIGHT*** is visible from all angles and provides easy bulb change. Enclosure available with either one or two factory-mounted lights or can be furnished with plugged holes for field installation. Stainless steel thread-in-thread construction gives corrosion-resistance and easy servicing.

EASY TO INSTALL with *slide and hook* mounting arrangement for interior equipment—a Square D "exclusive." Takes the hard work out of the installation job.

STRONG AND LIGHTWEIGHT construction. Complete enclosure is cast aluminum. All operating shafts are stainless steel, thread-in-thread, for the best in corrosion resistance.

Square D *is Better in So Many Ways!*

When you buy from Square D, you not only get all the benefits shown above—you also are buying from the only manufacturer who builds both the enclosure and the starter, giving you unit responsibility. Moreover, Square D offers better stocks, better on-the-spot service. That's why it makes sense to insist on Square D Spin Top enclosures for your hazardous location applications.

4 ENCLOSURE SIZES ACCOMMODATE NEMA SIZES 0 THROUGH 5

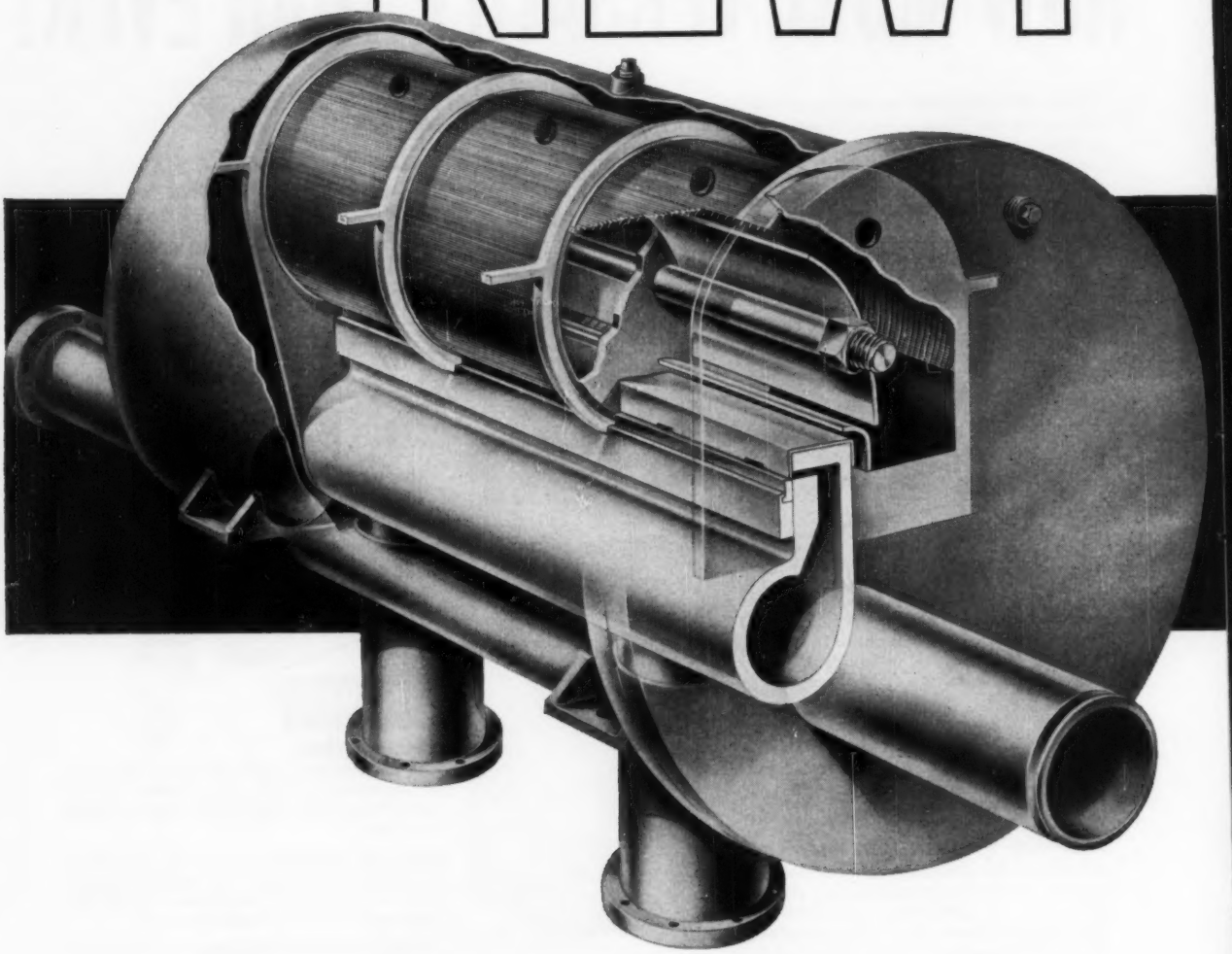
Square D Spin Top enclosures are NEMA 3 (weatherproof), NEMA 4 (watertight), NEMA 7 (explosion-proof) and NEMA 9 (hazardous locations) for Class I, Group C and D; and Class II, Groups E, F and G service.

Write for Bulletin 9990. Square D Company, 4041 North Richards Street, Milwaukee 12, Wisconsin

SQUARE D COMPANY

wherever electricity is distributed and controlled

NEW!



Principle of operation

Feed is introduced through a flat nozzle at sufficient velocity to travel around the 300 degrees of screen. All material coarser than 40 microns is collected on the surface and discharged. Liquid and minus 40 micron material passes through the wedge bars and collects in a separate compartment for return to process. As an example, a refinery had trouble in the distillation column due to particle breakover into the light phase of a two phase condensate system. Installation of 300° DSM Screen corrected the problem by treating 450 gpm of condensate containing 100 ppm of trace particles. Results: 95% of all solids removed in a 60% by volume concentration; distillation column returned to full efficiency operation.

THE DORR-OLIVER 300° DSM® SCREEN

...Provides high capacity separations down to 40 microns

A new development in wet screening techniques, the 300° DSM Screen provides unique operational advantages for the Hydrocarbon Processing Industries. From the standpoint of *efficiency*, the unit will positively remove all particles 40 microns or larger from production streams. On a *capacity* for size basis, a single unit occupying only 9 cubic feet can handle 500 gallons per minute. And for design *flexibility*, DSM Screens can be supplied for atmospheric, vapor tight, vacuum or pressure operation. There are no moving parts and pump pressure is all that is required for operation.

Typical applications include:

- Removal of trace impurities in condensate lines from stripping operations.
- Counter-current washing or extraction in any number of stages.
- Classification of polymer crystals.
- Protection of phase separators in multi-liquid phase systems.
- Protection of distillation columns.

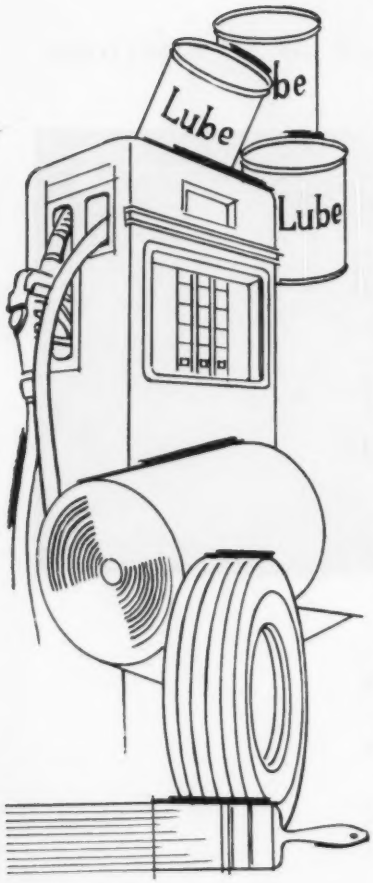
If you have a liquids-solids separation problem involving high capacities, small particles, any or no difference in specific gravities, or two or more liquids, it will pay to investigate the 300° DSM Screen. As performance characteristics vary with the material being handled, Dorr-Oliver has trial units available on a minimum rental basis for pilot or semi-works testing. For more information, write to Dorr-Oliver Incorporated, Stamford, Connecticut.

DORR-OLIVER

WORLD-WIDE RESEARCH • ENGINEERING • EQUIPMENT

For more data on advertised products, use cards, last page.

QO® Furfural offers Montage of uses as a selective solvent



Just as a montage is a composite illustration to an artist—QO furfural offers a composite of solvent extraction ideas for the chemical engineer. Furfural is highly polar which favors sharp separations of saturates from unsaturates in lube oils, gas oils, cycle stocks and other petroleum products as well as wood rosin, glycerides, butadiene. Supplementing the basic advantage of preferential solubility, furfural is easy to reclaim, easy to handle, and easy to buy.

Uses for which QO furfural offers advantage as a selective solvent include:

Lubes: In the furfural refining of lube stock the undesirable aromatic and olefinic components are selectively dissolved and separated from the desirable paraffins and napthenes.

Cat Cracker Cycle Stock: Furfural treatment of cycle stock sharply reduces carbon lay down on the catalyst which means improved cracker efficiency and greater gasoline out-put. Furfural reduces heavy metal contaminants, sulfur bearing materials and carbon residue.

Wood Rosin: Furfural removes color bodies from crude FF grade wood rosin to produce a light colored product equivalent to X grade.

Butadiene: In the purification of butadiene, furfural alters relative volatilities of butadiene and other C_4 hydrocarbons. This permits easy fractionation of compounds differing in degree of unsaturation to give good yields of high purity butadiene.

Glycerides: Glyceride oils may be separated by solvent extraction with furfural. Furfural selectively removes unsaturated glycerides from saturated ones.

If you have a separation problem, furfural may well be your answer. Write for information indicating nature of material to be extracted.

The Quaker Oats Company

CHEMICALS DIVISION

The Quaker Oats Company — CHEMICALS — QO QUAKER CHEMICALS — DIVISION

340U The Merchandise Mart,
Chicago 54, Illinois

Room 540U, 120 Wall St.,
New York 5, N. Y.

Room 440U, 48, S.E. Hawthorne Blvd.
Portland 14, Oregon

In the United Kingdom:
Imperial Chemical Industries, Ltd., London, England

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Quaker Oats (France) S. A., 3, Rue Pillet-Will, Paris IX, France;
A/S "Ota", Copenhagen, S. Denmark

In Australia:
Swift & Company, Ltd., Sydney

In Japan:
F. Kanematsu & Company, Ltd., Tokyo

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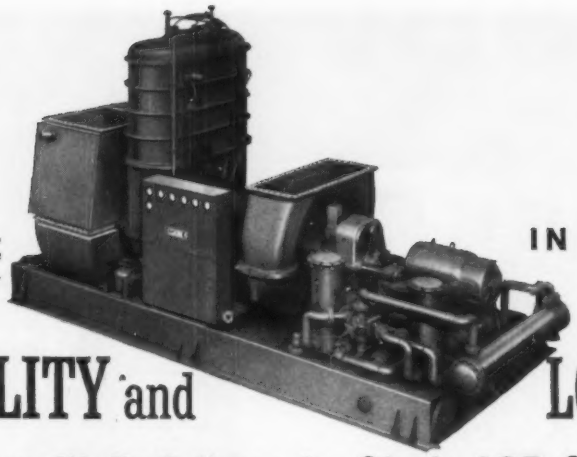
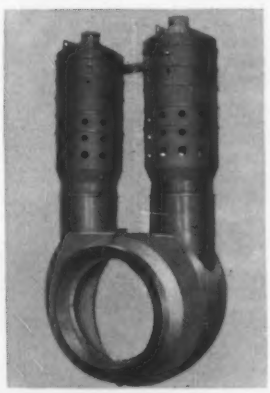


Clark Model 305-S, single shaft gas turbine rated at 9000 hp.

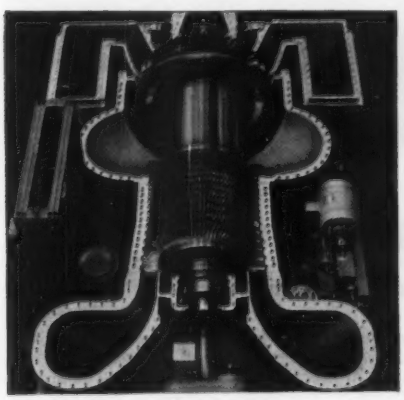
IN GAS TURBINES YOU LOOK FOR RELIABILITY and LOW FIRST COST

Here's why you'll find them in Clark 305 Series Gas Turbines

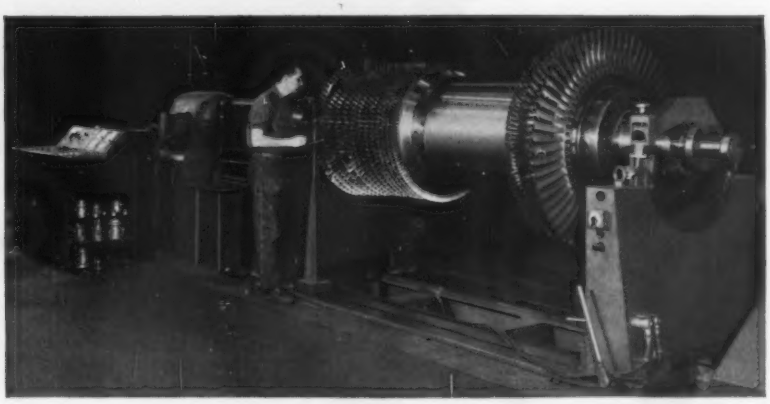
- **Heavy Duty Industrial Design**—Simple, open cycle machines, built for continuous, full load operation . . . ideal drivers for compressors, generators and pumps.
- **Single Shaft Construction**—Provides high rotating inertia and minimum speed variations under transient load conditions. Two-Shaft units available for applications requiring wider operating flexibility.
- **Design Simplicity**—Integral compressor-turbine rotor is supported by two readily accessible journal bearings. Entire unit including combustion system is contained in common casing structure.
- **1400°F Operating Temperatures**—Insure long life of hot parts plus substantial margin of safety.
- **Air Cooled**—Pressurized air cools high temperature components . . . air envelopes minimize heat loss and operating temperatures wherever possible.
- **Vertical Combustion Chamber**—Prevents direct flame impingement on turbine blading . . . assures more uniform heat distribution.
- **Horizontally Split Casing**—Upper half can be removed in one piece to remove rotor . . . inspections quickly made using light lifting equipment.
- **Renewable Labyrinth Seals**—Of honeycomb construction . . . minimize leakage at all close clearance points on turbine shaft.
- **Proved Reliability**—Materials of construction and important components such as turbine blade root design, turbine discs, journal bearings and axial compressor based on broad Clark experience in building heavy duty gas turbines.



Unitized combustion chamber with two parallel burners, each enclosed in a liner of high temperature nickel chrome alloy.



Single rotor is supported by two journal bearings for greatest simplicity. Horizontally split housing provides easy accessibility.



Rotor is statically and dynamically balanced for optimum performance. Turbine blades are of high temperature forged steel. Air streams cool turbine blade roots and both sides of discs.

You are invited to get full details on how Clark 305 Gas Turbines can bring you lower first cost, reduced floor space and installation costs, plus dependable, economical performance. Contact your nearest Clark representative or write for Bulletin 186.

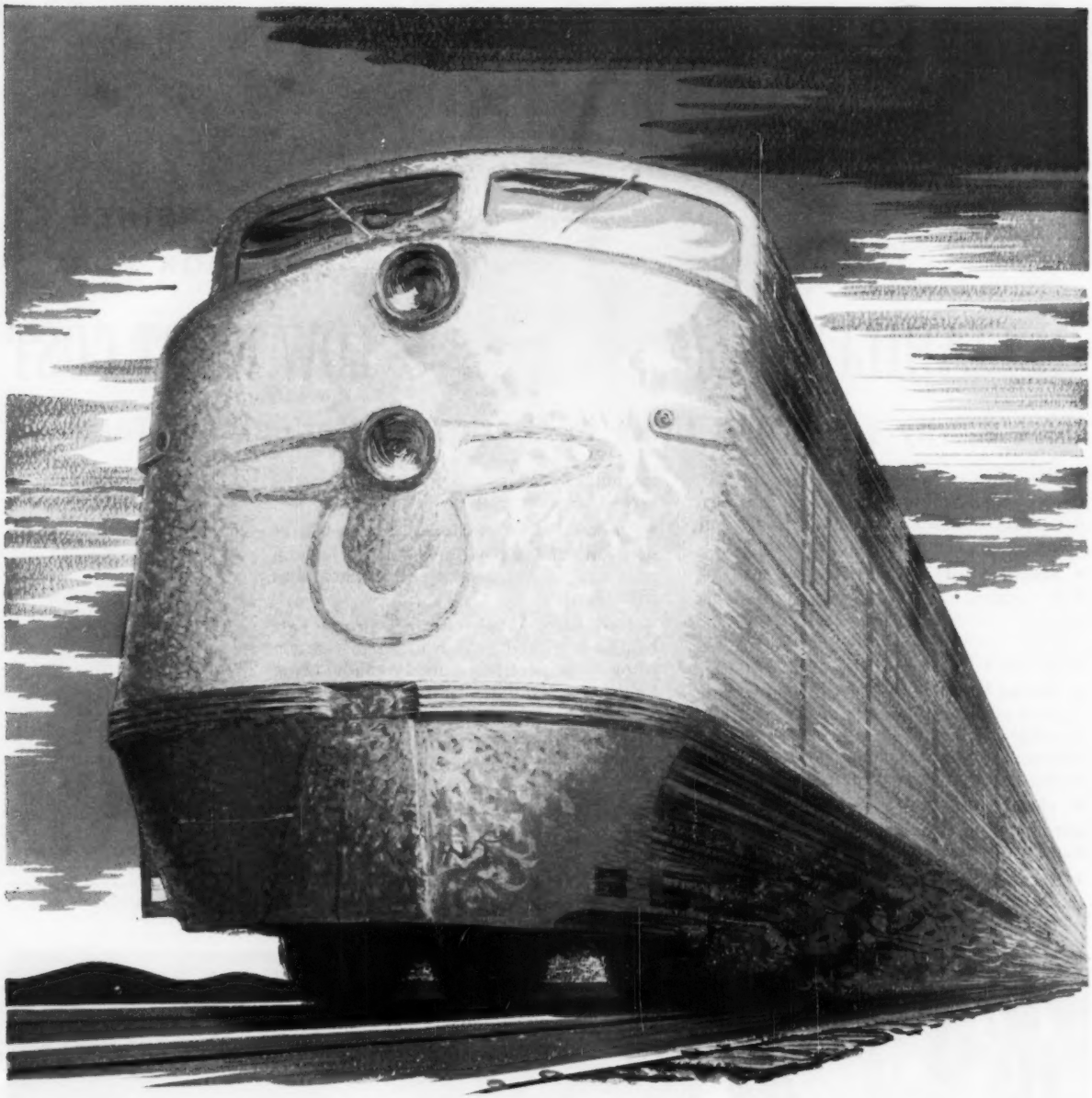
CLARK BROS. CO., OLEAN, N. Y.

CLARK

DRESSER INDUSTRIES INC.

OIL • GAS • CHEMICAL
ELECTRONIC • INDUSTRIAL

For more data on advertised products, use cards, last page.



Flexitallic®
SPIRAL-WOUND GASKETS

Power in a new "package"

...where gaskets must not fail

In almost every industry, light-weight turbo-charged Diesel engines are placing new responsibilities on Flexitallic Gaskets.

To insure a proper seal under specified service conditions, each Flexitallic Spiral-Wound Gasket is designed with the application in mind.

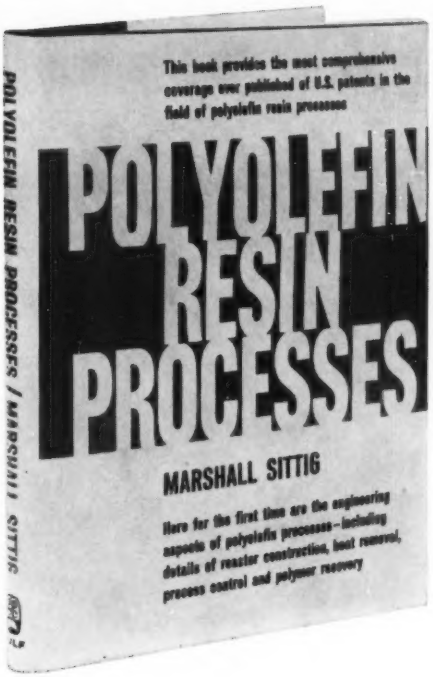
Starting with the flange geometry, the bolt load, temperatures and pressures to be encountered, fluid or gas to be contained — the Flexitallic engineer designs for dependable sealing with an extra margin of safety, consistent with design of the assembly.

Selection of the proper metal, the proper filler, and the proper yield characteristics in the gasket are essential steps in meeting specific operating conditions — corrosion, vibration, thermal and physical shock.

Give us the facts about your most serious sealing requirement — in chemical processing, petroleum, power, marine, aircraft and missiles, diesel, or any other field. There's a Flexitallic Gasket to meet your needs — or Flexitallic will design one.

Flexitallic Gasket Company, Camden 2, New Jersey. Stocking Distributors for Standard Flexitallic Gaskets in principal cities.

Just Published


This book provides the most comprehensive coverage ever published of U.S. patents in the field of polyolefin resin processes
POLYOLEFIN RESIN PROCESSES
MARSHALL SITTIG
Here for the first time are the engineering aspects of polyolefin processes—including details of reactor construction, heat removal, process control and polymer recovery
POLYOLEFIN RESIN PROCESSES / MARSHALL SITTIG

POLYOLEFIN RESIN PROCESSES

By Marshall Sittig

240 Pages, 65 Figures, 14 Tables

Price $6.50

This book provides the most comprehensive coverage ever published of U.S. patents in the field of polyolefin resin processes.

Here for the first time are the engineering aspects of polyolefin processes—including details of reactor construction, heat removal, process control and polymer recovery.

ABOUT THE BOOK

In this book the reader will find all U.S. polyolefin patents listed in order of application. This listing contains patent application serial number, date, U.S. patent number and book reference number.

It covers solid (rather than liquid or viscous) polymers and concentrates on resins, homopolymers of aliphatic mono-olefins and some copolymers of olefins with other olefinic hydrocarbons.

It also covers the process starting with olefin raw material and concluding with a purified polymer.

Thus it includes catalyst and solvent recovery with attendant steps between olefin and polyolefin. Admixture of aluminum alkyls and other compounds to produce the actual complex metal catalysts are considered.

To Order

Just fill in the order form below. Then mail the form to us. Your copy of Polyolefin Resin Processes will be shipped promptly on receipt of your order.

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Polyethylene, polypropylene, polymers of higher olefins, production volume, process trends, product trends, patent and licensing activity, raw materials, process characteristics, catalysts, processes using non-metallic catalysts, processes using metal-derived catalysts, polymer properties, bibliography, list of U.S. polyolefin patents.

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For more data on advertised products, use cards, last page.

U.S.A. — World's largest wax manufacturing plant, built at the Philadelphia refinery of Atlantic Refining Company.

Belgium — Phthalic anhydride plant for Union Chimique Belge S.A., Brussels.

Mexico — Citric acid plant for Quimica Mexama S.A. Drawing includes proposed future expansion.

Holland — Complete 100,000 bpsd "grass roots" refinery constructed for Esso Nederland in the vicinity of Rotterdam.

Taiwan — 600 bpsd sulfuric acid alkylation plant for Chinese Petroleum Corp., Kaohsiung.

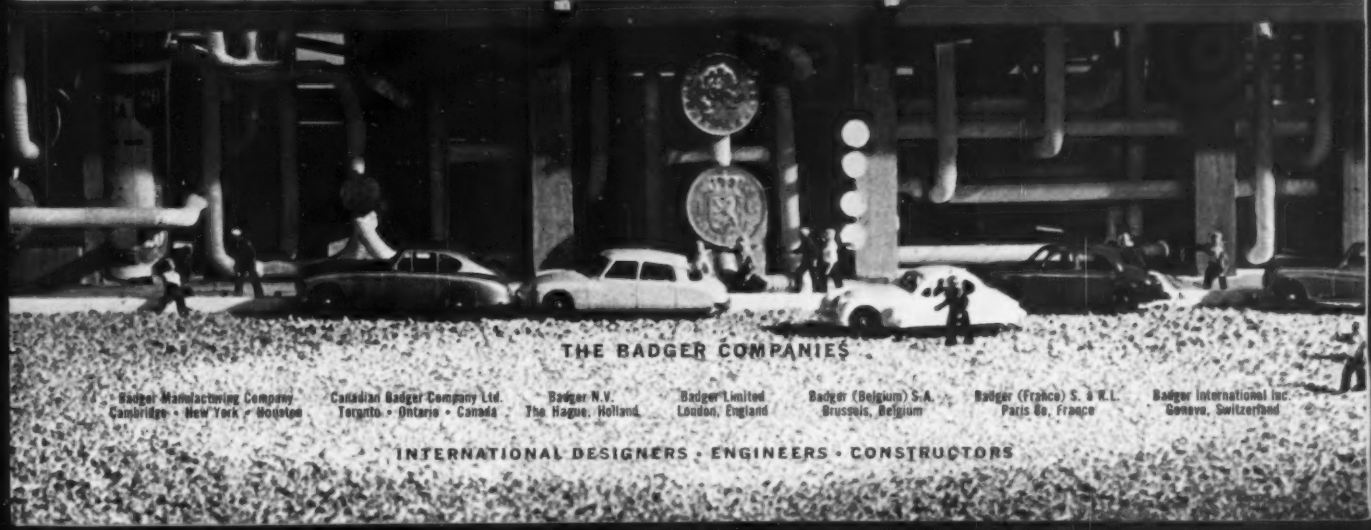
Spain — Fractionation unit for Empresa Naçional Calvo Sotelo.

money-making plants at home or abroad built by BADGER

Chemical and petroleum producers in search of international profits are turning their engineering and construction projects over to Badger in growing numbers. To date, Badger has helped clients make their money talk in thirteen languages.

How do you benefit by working with Badger overseas? You work with people who know local conditions, your problems, their jobs. Affiliate staffs – on the spot in seven countries – include top talent of the locale combined with seasoned Badger career personnel. And you deal in indigenous currencies.

When you are considering a money-making plant anywhere abroad, ask Badger for help. The full story on facilities and services is as close as the nearest office – write, wire or phone.



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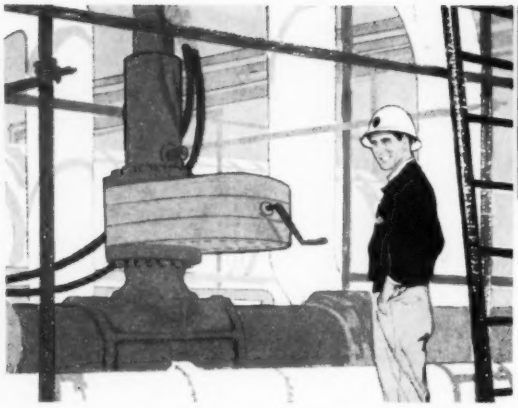
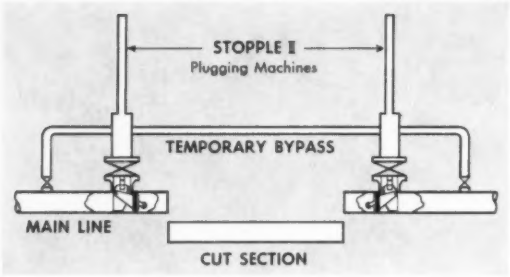
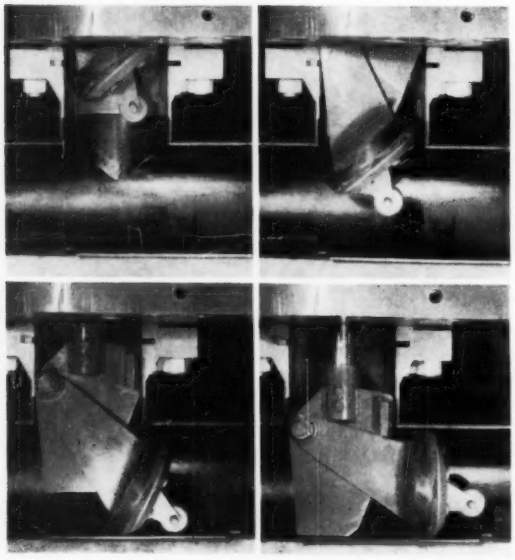




❶ "This method of plugging a line and bypassing the flow has been used extensively in plant and field operations with WMSon tapping and STOPPLE equipment. Many costly shutdowns have been avoided. Now, WMSon engineers have re-designed and improved the STOPPLE Plugging Machine. Result . . . the all new STOPPLE II . . . offering hydraulic operation, improved, simplified construction, and economy—**real** economy!"



❸ "Here's how STOPPLE II works. After the tap is made, the STOPPLE II is mounted on a WMSon SANDWICH Tapping Valve, and the plugging head is lowered into the line, stopping the flow completely. New single link construction of the plugging head offers built-in simplicity . . . and strength for high pressure plugging."

NEWS FROM DOWN THE LINE!

NEW economy
NEW improved design
NEW interchangeable plugging heads . . .

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Plugging Machine for piping modification or repair WITHOUT SHUTDOWN!

❷ "Here's the major reason for this economy. The STOPPLE II has a hydraulic cylinder that is interchangeable with plugging heads of different sizes. For example, one hydraulic cylinder can be used on a 14", 16", 18" or 20" line by using it in combination with a plugging head and housing of the proper size."

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WMSon STOPPLE II with hydraulic operation is available in sizes 8"–30". The 4" and 6" units are hand operated. Single link is standard in all sizes. Write for additional information and specifications:

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REPRESENTATIVES AROUND THE WORLD

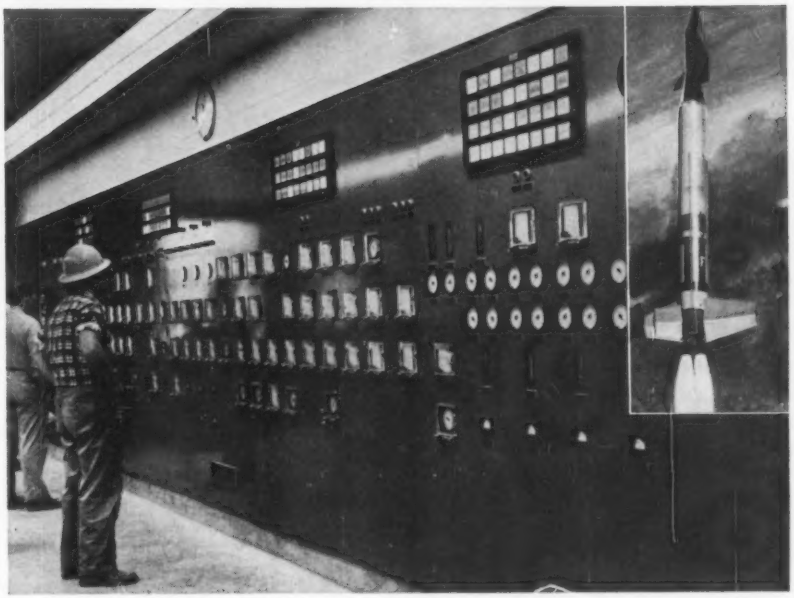
What's Happening in HPI...

Technology

Phthalic Acids From Xylenes

Cowles Chemical and Catalytic Construction are up with a new process for phthalic acids production from xylenes—Catalytic to be licensing agent. The process is "capable of producing any one of the phthalic acid products from the individual xylene isomers." Catalytic offers immediate application of the process to the manufacture of phthalic anhydride from o-xylene. The Cowles process involves continuous liquid phase catalytic oxidation.

The trend: Although isophthalic acid is considered a substitute for phthalic anhydride, a trend toward new uses and applications is developing. Terephthalic acid, in the form of dimethyl terephthalate, is used to make polyester resins.



Nerve center of the world's largest anhydrous hydrazine plant. The control panel virtually runs the $15-million facility, which was built by Olin Mathieson for the U.S. Air Force at Saltville, Va. The storable liquid fuel will power the Titan II ICBM (inset).

Pilot Plant Problem?

The chemical processing industry should explore alternate methods or techniques before building costly integrated pilot plants for new product investigation. So says Charles R. Wiesinger, Du Pont, Wilmington, in a paper, "Why Pilot a Process?"

The author's views: "Because of the present level of knowledge and techniques and tools available, a fully integrated pilot plant program should be an exception rather than the rule in process development. Available alternate methods or techniques include well devised bench scale tests. These can demonstrate yield and conversion, prototype equipment, mathematical analysis, experiments using pots and pans to test the effect of recycle, temperature, degradation, fluid flow characteristics, reaction rates and corrosion and coalescing problems.

"A typical over-all time span for new product development might show an interval of six to eight years, two to three of which may be used for pilot plant activities. It is the engineer's job to shorten this. For a normal product, the incentive to reduce this 'normal span' is probably $250,000 per month commercial return. Pilot plants are expensive, ranging from $100,000 to $200,000 in initial construction, and $500,000 to $1 million a year in operating costs. They are time consuming in construction, confused by process upsets, time consuming in analyzing meaningful results. Their existence restricts the careful examination of alternates. In extreme cases, the pilot plant can become a bottleneck to the rapid commercialization of a new product . . .

"Chemists and engineers tend to become emotionally involved in a process, and it may be difficult to change horses even when the horse shows signs of breaking the second leg. The tendency is to 'make it work' in spite of all difficulties.

"On the other hand pilot plants can test scale-up ability, reduce the potential of costly mistakes, and provide small lots. When the product is polymeric, a pilot plant is almost always necessary for market evaluation purposes. The processing of solids might also require extensive piloting for demonstration. However, when the new product is a compound whose chemical composition and not physical characteristics determine sales potential, this is not a factor."

SoCal's Computer

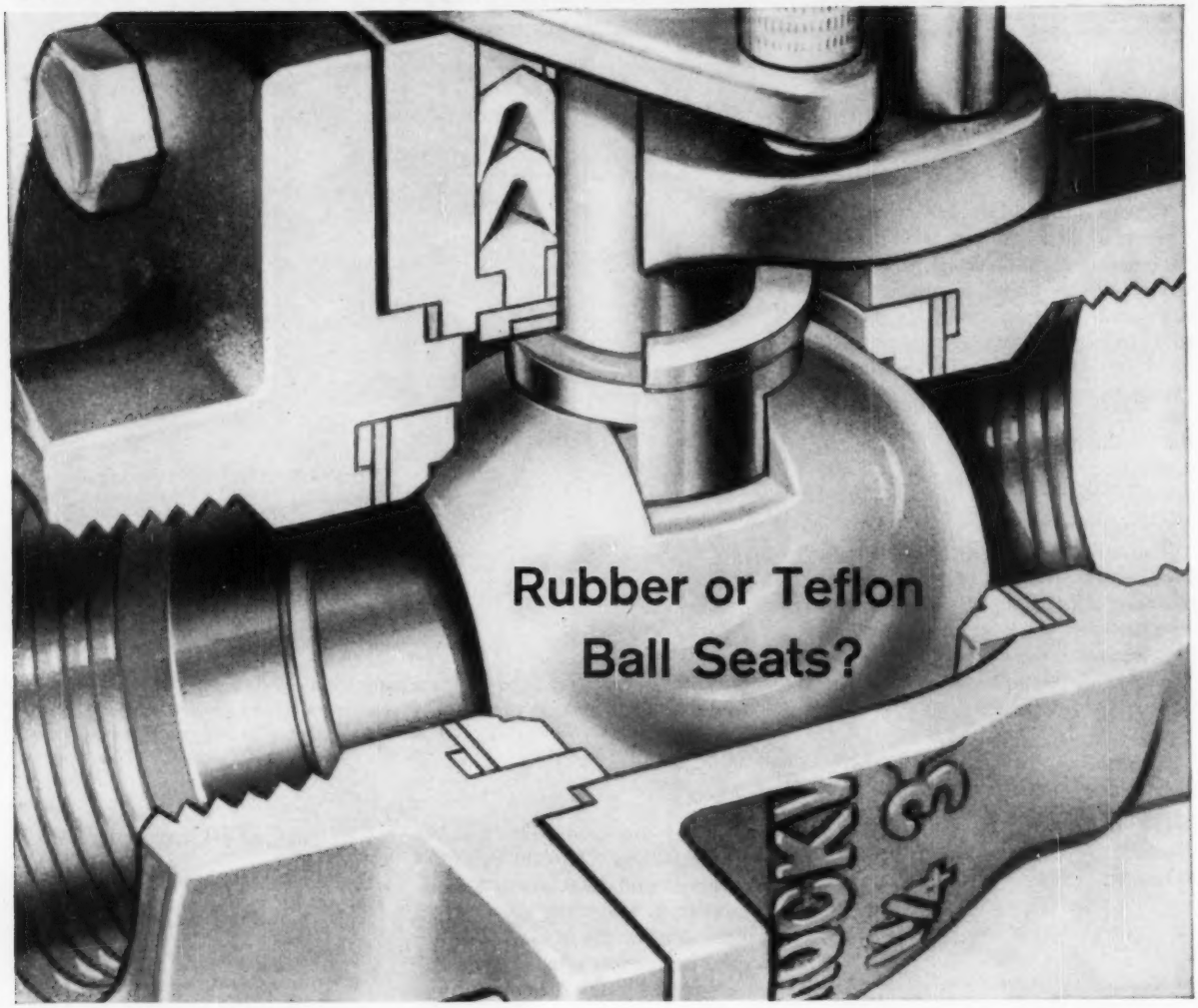
SoCal claims its fluid catalytic cracker is the largest, most complex refinery unit ever to be coupled to a computer setup. The custom-built installation of a process-control computer system at its El Segundo, Calif., refinery will be completed and in operation soon. Is the loop closed? The operator can close it on the most important control variables—and that feature is expected to become a regular practice.

Electrostatic Mixing

Electric charges to precipitate pollutants in air and gas streams have long been used, but a way has been found to mix chemical substances by an electrostatic field. "The advantage of mixing this way over conventional methods is that no moving equipment, such as impellers or circulating pumps, is required," so say W. P. Cropper and H. S. Seelig, American Oil, Whiting, in a paper, "Mixing With An Electrostatic Field."

Say the authors: "The new process offers promise for mixing liquid sulfur dioxide, or liquid hydrofluoric

TAKE A CLOSE LOOK AT ROCKWOOD BALL VALVES



Rubber outperforms any other material in ball valve seats. It seals tighter, lasts longer because it is tough, resilient and resists abrasion. Teflon is used when *corrosion resistance* and *high temperatures* are prime factors.

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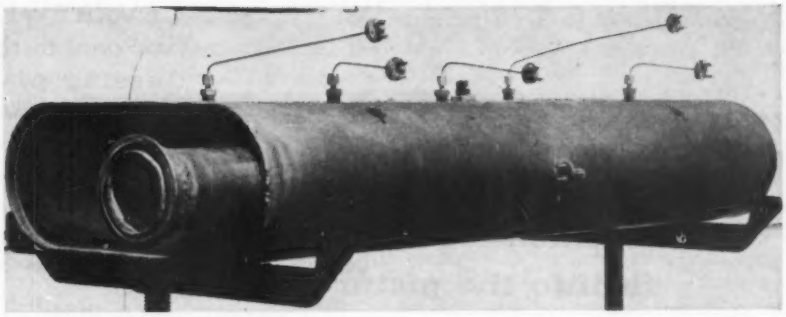
BALL VALVES

acid, with hydrocarbons. Spectacular results were noted in mixing isooctane with aniline and nitrobenzene; "excellent" results with pyridine, isopropanol, and ethyl acetate; "good" results with furfural, methanol, nitromenthane, ethylene glycol and acetic acid (glacial), but "poor" results with 1, 4-dioxane, sulfuric acid (conc.) and water."

In small-scale apparatus power consumption is similar to that for conventional mixing equipment. The new process, using a nonhomogenous electrical field, operates on a macroscopic scale.



Through catalytic action initiated by normal exhaust temperatures, this device oxidizes or burns hydrocarbons and converts the poisonous carbon monoxide in exhausts to harmless vapors. Attachments at the top are thermocouples for test purposes only.

Gas & Catalyst Analysis

A pilot plant for speedy analysis of gases and catalyst has been devised "to simulate commercial plant operation and to test and screen many different catalysts," so says John D. Potts, Houdry Process, Philadelphia, in a paper, "Catalyst Testing Pilot-Analyzer System."

The author's story: "The feed gases and off-gases from the unit were analyzed 'continuously' in a gas chromatograph. This pilot unit-analyzer system, tested operating characteristics of a catalyst at three operating conditions in about seven hours. Approximately 200 catalysts were investigated at from one to six temperature conditions within a 10-month period. The system provided a rapid means of screening many catalysts at varied processing conditions. It proved the feasability of adopting a gas chromatograph for 'immediate' feed-gas and product gas analysis. Immediate availability of the analytical results provided maximum use of manpower and equipment in a given program. With few modifications, the pilot unit was later adapted for a liquid phase organic chemical process currently under investigation."

Plant & Office Automation

A new era in industrial automation, in which automatic controls in the plant will be "wedded" to data-processing office equipment, is shaping up for U.S. industry, in the view of a Minneapolis-Honeywell executive. "The success of this marriage could be the greatest industrial event of the sixties," says George M. Muschamp, Honeywell vice president of engineering. His views: "Automatic operations in plants and offices already have a high degree of development, and it is possible now to merge them. We can reorganize the paper work—the present end product of most automatic office equipment—so that the information, in addition to serving as a record, can be fed automatically into plant control systems . . . We can automatically get, from the process, information needed for control and accounting. We can feed the information back to the process for control. This will lead to parallel automatic operations in place of the present man-machine serial operations."

"In the coming automation era, systems engineering will play a key role, with both management and engineering consultants becoming increasingly involved in the evolution . . . This means using mathematical models where they are applicable, dynamic analysis and servo mechanism theories where they are justifiable, and common sense when none of the sophisticated techniques apply."

The 'Unattended' Plant

Sunray has lost little income from shutdown periods in its several "partially unattended" gas processing plants in Texas and Oklahoma. One plant has been shutdown 12 times in two years, but the loss has been only $80 per outage, or $40 per month. Another plus for this operation is the product quality, somewhat better than attended plants. Biggest problem: Plant operation difficult during swings in rich gas throughput.

Computers and Chemicals

Monsanto is up with the first major chemical complex ever to be designed from the ground up for computer control—its big Chocolate Bayou, Texas, project. Plans call for a number of computers, each one monitoring one or more units. One major computer will correlate and direct operations for the aggregate complex, making economic optimizations and guiding the computer's operators.

Economics

Venture Analysis: New Route to Better Business

Top economists from the HPI revealed how their companies evaluate new business opportunities, at a recent meeting of AIChE's Delaware Valley Section. Here is what speakers revealed in this "venture analysis" session.

- Hearty competition in the industry has forced most companies to use a more precise method for evaluating new business venture. It is now necessary to carefully predict future earnings of all long range investments. Industry must use mathematical methods for evaluating these earnings which are based on the concept that a dollar earned today is worth more than a dollar earned tomorrow.
- Market evaluation in predicting the future earnings of investment opportunities is very important. Evaluation in the field of plastic products has to be made in 60 to 90 days if a company is to get into this market before it is overcrowded.
- The Theory of Games, the mathematical concept of card playing, is being used to select new locations for

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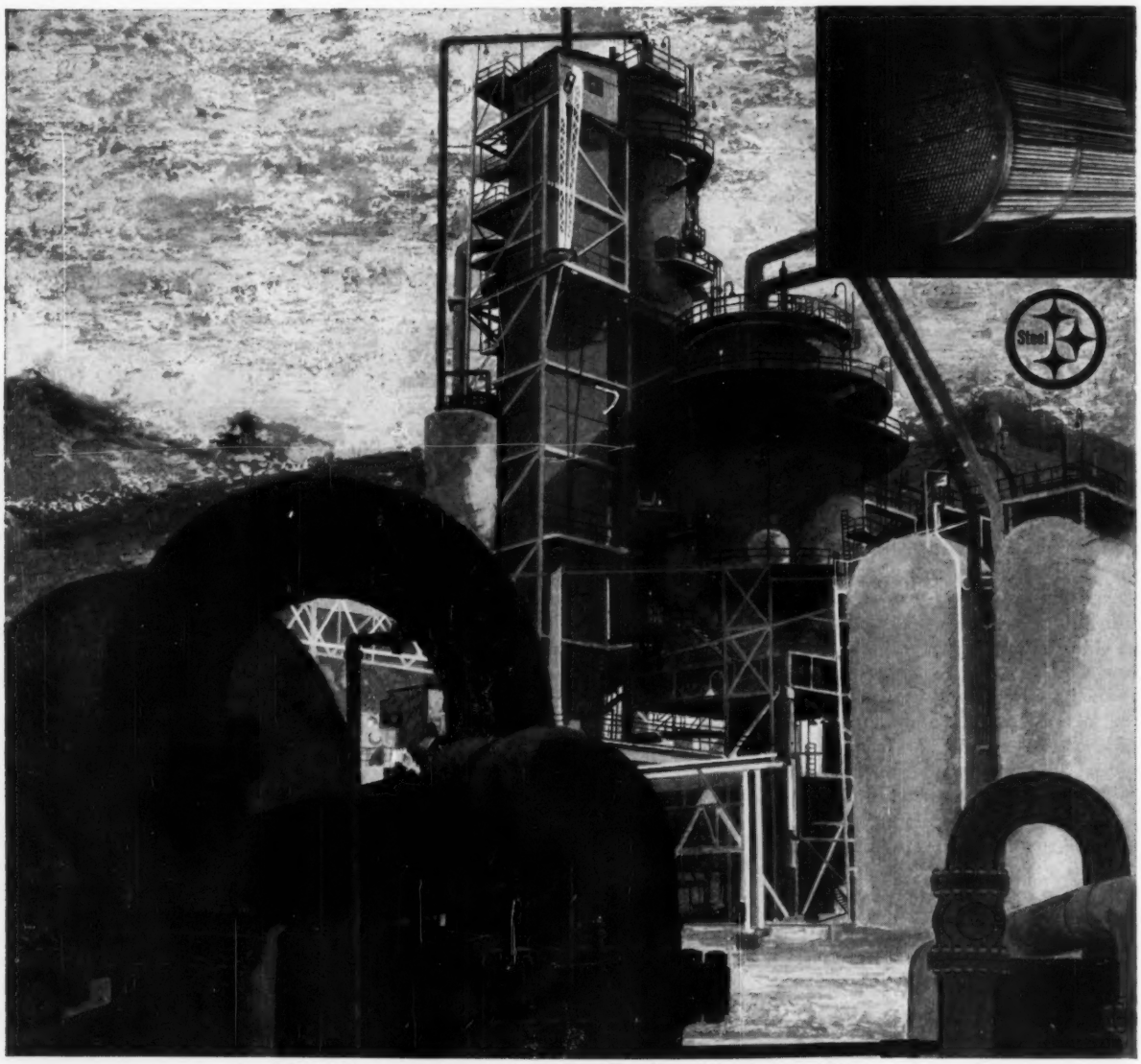

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plants. This method of analysis is so time consuming, a computer is needed.

- Du Pont is using computers to make complete process and product evaluations using the new more detailed mathematical methods of evaluating. The use of computers to evaluate potential ventures allows Du Pont to rapidly find attractive investment opportunities from their research efforts before the market is saturated.
- The engineering economist must not oversimplify his function of key responsibility. Five cases of oversimplification which led to poor investments were cited, pointing out it is up to the engineering economist to develop weakness as well as strengths of the opportunity he is evaluating.
- Management has the responsibility of selecting capable engineering economists for evaluating investment opportunities. Management also has to clearly define the areas of responsibility to these evaluators. They must properly consider the risks and chances of success when making the decision on the engineering economists recommendations.
- The evaluation of an investment by an individual is different than an investment by a large corporation. The personal factors such as family security and one's life span have significant weight when considering investing personal capital in a new venture.

The nine experts speaking were from Atlas Powder, Sun Oil, Du Pont, Socony Mobil, W. L. Gore & Associates and Robert S. First, Inc.

The Chemicals Future

A sharp rise in production will be necessary if chemical processing companies are to maintain their competitive position in 1965 and 1975, says George W. Blum, Goodyear Tire & Rubber, Akron, Ohio. "Sound economic appraisal within the chemical process industries has been accompanied by conflicting conditions during the past several years," he reports in a paper, "Analysis of Capital Cost and Repayment for Industrial Expansion."

"Earnings have been better than in industry as a whole, but have frequently fallen below the averages of preceding years. Sales in 1960 generally exceeded the 1959 figure, but the sales curves have shown a flattening trend. Profit margins leveled off or sharply shrunk. Rising operating costs, frequent reductions in selling prices, and expanding competition severely strained decisions and policies . . ."

"In order to maintain its present competitive position in the industry, a company will be required to produce about 40 percent more in 1965 than it did in 1955. By 1975, it must produce 100 percent more than in 1955, with only about one-tenth more hours worked."

Products

Petroleum Dominating Aromatics Market

Petroleum and chemical companies threaten to take the aromatic chemicals market away from the coke oven producers that have traditionally dominated the market. Coal's one chance for survival is to market material of comparable quality to petroleum-derived BTX and naphthalene.

The petroleum industry captured the major portion of the benzene market for the first time in 1958. Since then, an overabundance of catalytic reforming capacity and shortages of coke oven aromatics due to the steel strike have encouraged petroleum companies to go after the aromatics market aggressively.

Market estimate for 1965 benzene consumption is 800 million gallons, about 350 million above today's demand. To meet this, petroleum companies have 390 million gallons of capacity planned for completion before the end of 1962. Thus, petroleum companies could supply over 750 million gallons of the expected 800-million-gallon 1965 market.

Naphthalene, still dominated by coke oven producers, is slated to follow the same path, while coke oven naphthalene capacity will hold steady at 642 million pounds.

Petroleum naphthalene's present capacity of 100 million pounds will jump to 450 million pounds by the end of next year.

Key to holding the aromatics market is essentially product quality. Petroleum benzene, for example, has a thiophene content of less than 1 ppm. Coke oven benzene generally has a thiophene content of 250 to 1,000 ppm.

Galloping Ethylene Horse

Ethylene plant capacity in the United States "will grow from the present 6 billion pounds per year to about 10 billion by 1970. Other light olefins such as propylene, butylenes, and butadiene will probably have an even higher growth. So says J. A. Knaus and J. L. Patton, M. W. Kellogg, New York, in a paper, "Effect of Feed Composition on Ethylene."

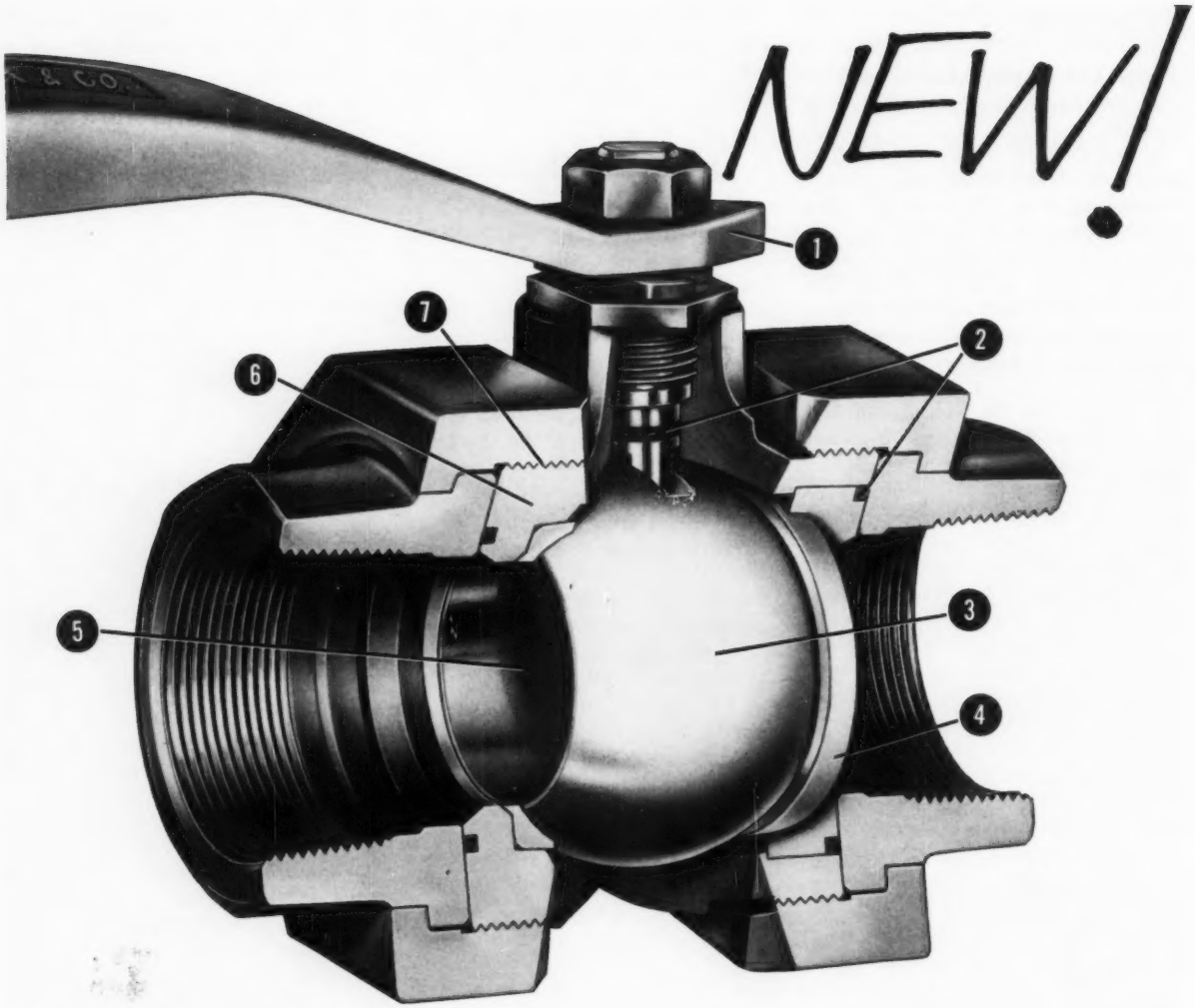
The author's story: "A part of the demand for these products can be met by recovery from petroleum streams (but) most must come through such techniques as thermal or catalytic conversion of petroleum fractions. Light olefins have had an outstanding growth rate in the past two or three decades. In particular, ethylene production has grown about 400 million pounds per year in the past decade. This has been spurred chiefly by a combination of recover from refinery gas streams and by the dehydrogenation of natural gas and gasoline hydrocarbons."

"The effect of composition of light naphthas on pyrolysis production distribution can be predicted from the analysis of the feed stock. Variations in feed composition in the light naphtha range markedly affects the ratio of by-products to ethylene. Investment cost and operating costs show significant variations as feed stock composition is changed. In the production of ethylene from light naphthas, feed stock selections can be a tool to control the simultaneous production of by-product olefins, diolefins and aromatics to meet different market situations."

"Natural gasoline and naphtha have become less desirable in the United States because of the difficult and expensive task of upgrading them for blending. For this reason, these fractions are readily available as pyrolysis feed stock. As liquid feed stock is easily transported and stored, chemical plants using them can be located away from the refinery and be entirely independent of its operation."

LPG & Petrochemicals

Demand for LPG as a new source for petrochemicals is soaring. It is expected to hit slightly over 2.1 billion gallons this year, and continue steadily upward to peak at more than 3



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billion gallons a year in 1970. In 1960 four big-volume petrochemicals consumed 1.9 billion gallons of LPG (propylene, ethylene, isoprene and butadiene). In 1960, total LPG production in the United States hit 9.86 billion gallons. Thus, the amount going into petrochemicals was about 20 percent. Fractions going into the four petrochemicals will be butane, propane and ethane, the C 5s and naphtha, in that order. A trend to watch: Higher recovery of propane and ethane from natural gas liquids.

Dupe Ethylene Copolymers?

Duplicate ethylene copolymers may be in the making by competing companies, Dow Chemical and Union Carbide Plastics. The Dow brainchild is a copolymer of ethylene and ethyl acrylate, with end-use characteristics much like the flexible vinyls. Process advantages over the flexible vinyls is claimed, along with a less rigid temperature control, and elimination of compounding.

Carbide's pride and joy is described only as "a unique ethylene copolymer that can be regarded as a totally new material, rather than a modified polyethylene." Characteristics: stress-crack resistance of vinyl, flex-crack resistance of rubber, resiliency and elongation of polyethylene. Carbide has two patents related to the new product, but coverage of the ethylene-ethyl acrylate copolymer composition is not evident. Dow has applied for patents but none have been issued. Result of this may be a cross-licensing agreement.

Ethyleners Shift Gears

Some of the large ethylene producers are planning to operate on C-5 and heavier feeds in spite of a general trend to use light feedstocks for cracking to ethylene. They report that with the present motor-fuel oversupply, it is too expensive to convert these streams to gasoline. In the picture: Mobil Chemical, Beaumont, will feed naphthas and other gasoline stocks to its new ethylene unit there . . . Monsanto is going from a propane-butane LPG feed at Texas City, to a blend of light distillates and LPG. At its Alvin, Texas, ethylene plant, Monsanto will use distillates, light crude oils, condensates and gas oils produced by Lion Oil Division. About feedstocks: The heavy ones create additional by-products which can be consumed or sold by diversified petrochemical companies. Others will be switching to propane and ethane feeds to get higher yields and avoid the by-product outlet problem.

Two New Chemicals

Cities Service Research and Development is making two new chemicals —1,3-cyclooctadiene and 1,5,9-cyclododecatriene. Pilot plant production of the first four of a six-member family—1,5-cyclooctadiene, cyclooctene, cyclooctane and 4-vinylcyclohexene —has been under way since January. The 1,3-cyclooctadiene, which may prove useful in the manufacture of coatings, adhesives and reinforced plastics, is obtained by catalytically rearranging the double bonds of 1,5-cyclooctadiene—obtained by dimerization of butadiene. The conjugated arrangement of the double bonds of the new compound is expected to give it "a unique reactivity, allowing new uses not possible with an unconjugated diene."

The 1,5,9-cycloodecatriene—predominately the all-trans isomer—is made by cyclic trimerization of butadiene, using a new type of catalyst developed by Cities Service. It is expected to lead to a wide variety of di-and trifunctional 12-carbon chemicals. Best-known among these at the present time is 12-aminododecanoic acid lactam, a monomer which can be converted to a polyamide resin.

Helium Research Center

Amarillo, Texas, is the site for the Interior Department's new Helium Research Center, established to investigate characteristics and possible new uses of helium. Secretary of the Interior Udall says "the research program is a companion activity to the national helium conservation program now underway." He named Dr. Warren L. Brandt director of the new research center. He has been doing helium research with the Bureau of Mines since 1952.

Foamed Epoxy Resins

Interest is increasing in foamed epoxy resins, with Shell Chemical believed ready to go commercial with them. They would be very competitive with foamed urethanes because of better resistance to moisture and temperature, and lower toxicity in handling. On the other hand, urethanes have a price advantage, can be foamed with fluorocarbons, and make good insulators. Speculation has it that Shell may have found a way of foaming with fluorocarbons, or devised a way to increase the insulating qualities of foamed epoxies. Competitors on the sidelines wait for Shell's next move. Meanwhile, plans are in the mill for several firms to produce polyurethane foams in Mexico, Dow Chemical and General Tire & Rubber being the largest. The two firms each plan 600-ton-per-year plants. Market target: More and more air conditioning capacity in Northern Mexico, using large quantities of polyurethane for insulation.

New Butyl Rubber

A new type of butyl synthetic rubber has been developed by Esso Research and Engineering. The company's claim: A main feature is ozone resistance—"greater than that of any other commercial general purpose rubber, synthetic or natural." Because of its unusual molecular structure, the new rubber can sustain large loadings of fillers and plasticizers. This permits processors to "stretch out" a given volume without sacrificing the basic quality. It can be made in existing butyl plants, and processed into finished goods "just other types of rubber—more easily in some cases."

Resid Import Probe

Residual fuel oil imports and their effect on the national security will be investigated by the Office of Civil & Defense Mobilization. Written statements "respecting the relationship of residual fuel oil imports to the national security" can be filed before June 21 with the OCDM.

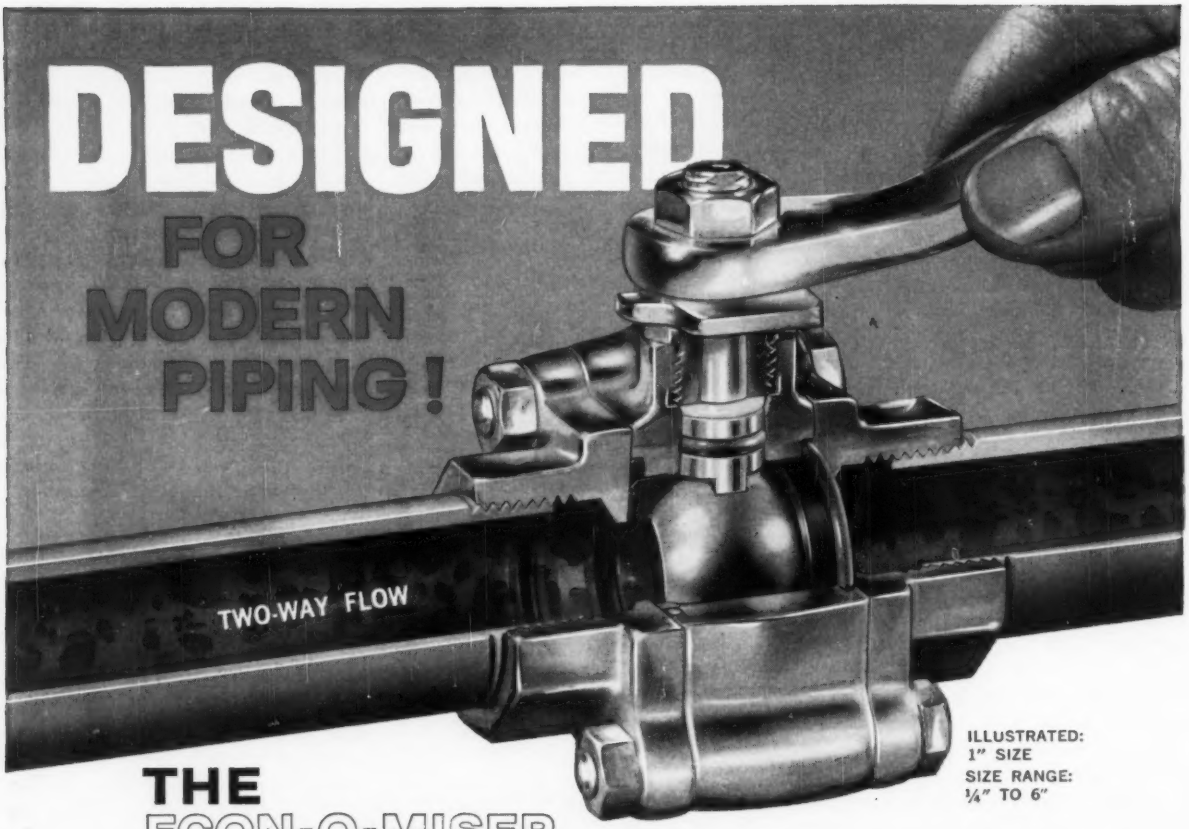
Original investigation requests and papers submitted to OCDM will be open to public inspection.

International Flavor

Soviet Exports & Refining

The U.S.S.R. believes that in the next decade it will be in a position to export 2 million bpd of crude oil. This figure appears in a report from official Soviet spokesmen to the L'Unita, Rome's Communist newspaper. Under the current Russian seven-year plan, says the report, construction of refineries in the Western Soviet Union will

continued on Page 268



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SIZE RANGE:
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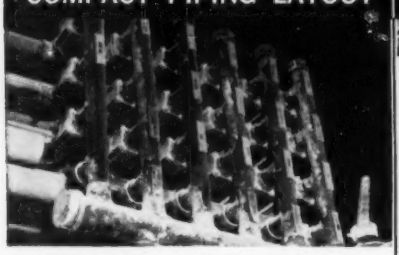
THE ECON-O-MISER BALL VALVE

COMPACT PIPING LAYOUT



Here are 19 Econ-O-Miser Ball Valves compactly installed on this paint blending manifold. Note the absence of unions . . . this valve is both a valve and a union! The Econ-O-Miser is smaller, easier to install . . . just right for modern piping layouts, where equipment must fit into tight areas.

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The Econ-O-Miser Ball Valve successfully controls the flow of cold glue with a viscosity of molasses, on the WORLD Tandem Labeler manufactured by Economic Machinery Co. Clean wiping action, positive leakproof shut-off, and smooth round flow, make the Econ-O-Miser ideal for handling difficult media.

Let us show you . . . in your own plant! Write us about your media problems!

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Outdoor propane and butane storage tanks in remote field processing plants require dependable positive shut-off valves on bleed lines. The unique features of the Econ-O-Miser Ball Valve provided the practical answer . . . no lubrication . . . no metal-to-metal contact . . . quick visual ON-OFF indication . . . trouble-free service.

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76 NH_3

A two month delay in the completion and start-up of a 350 ton per day ammonia plant can mean the loss of $1,500,000 in income. With 76 Chemico ammonia plants in operation or under construction (about six times as many as the nearest competitor), Chemico's experience is your assurance against such costly delays. Since 1955, for example, Chemico has undertaken 23 ammonia projects—all of them on time or ahead of schedule.

Chemico offers versatility as well as reliability in ammonia plant engineering and construction. Efficient and economical Chemico plants are operating profitably using natural gas, crude oil, fuel oil, electrolytic hydrogen or coke oven gas for raw material. If your company is considering the construction of new or expanded ammonia facilities, Chemico engineers would be pleased to recommend the process best suited to your needs. Address all inquires to: Sales Department.

CHEMICO

CHEMICAL CONSTRUCTION CORPORATION

320 PARK AVENUE, NEW YORK 22, NEW YORK

CHICAGO/DALLAS/PORTLAND, ORE/TORONTO

LONDON/PARIS/JOHANNESBURG/TOKYO

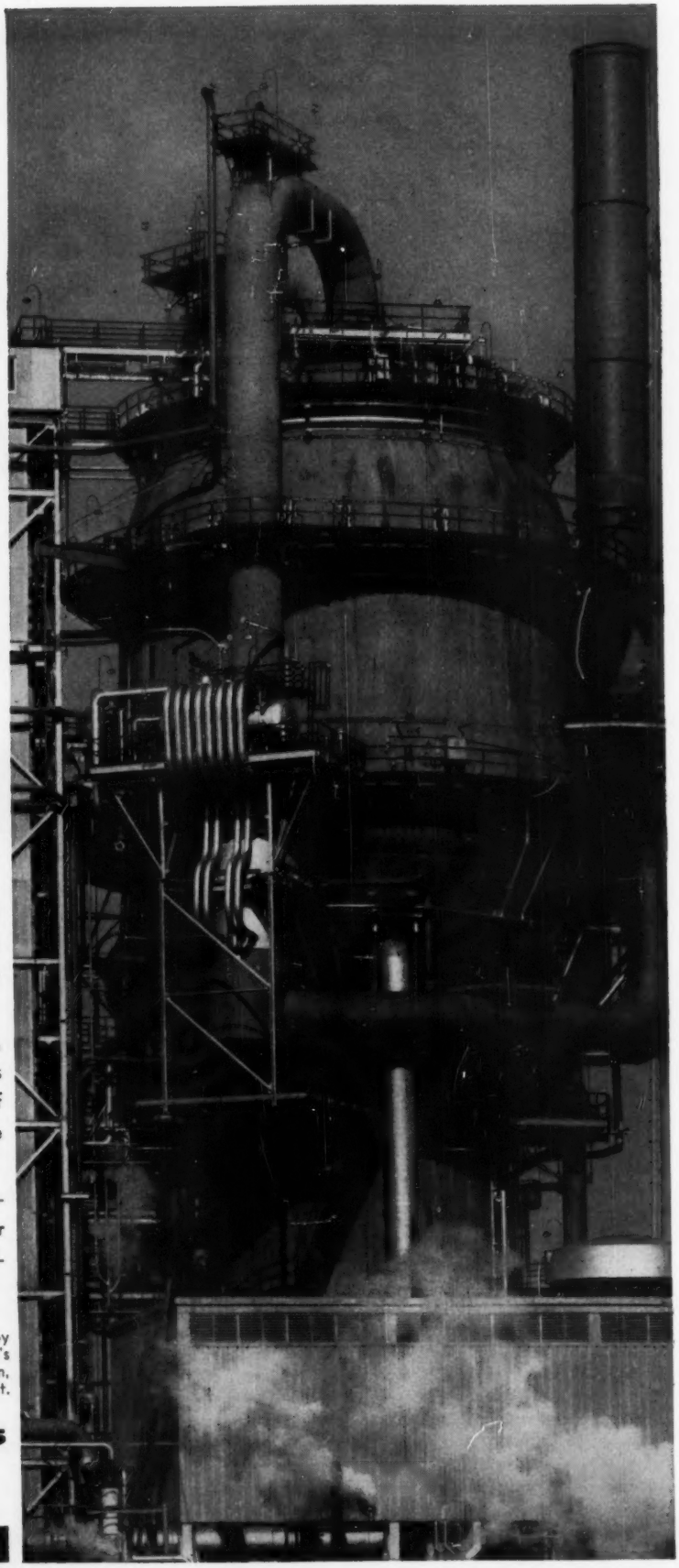
For more data on advertised products, use cards, last page.

BUILT TO TOWERING PROPORTIONS BY NEWPORT NEWS

Newport News has all of the specialized skills and equipment needed to fabricate heavy process equipment used by the petrochemical industry. For example, Newport News can roll plate up to 5 inches in thickness and weld almost any type of metal, utilizing the most modern equipment and techniques.

To match its modern production equipment, Newport News has expert staffs of engineers and technicians backed up by thousands of skilled workmen who use these facilities with the highest degree of craftsmanship.

If you are considering the construction of pressure vessels, vacuum tanks, towers, reactors or related equipment, you'll find it to your advantage to get a bid from Newport News.

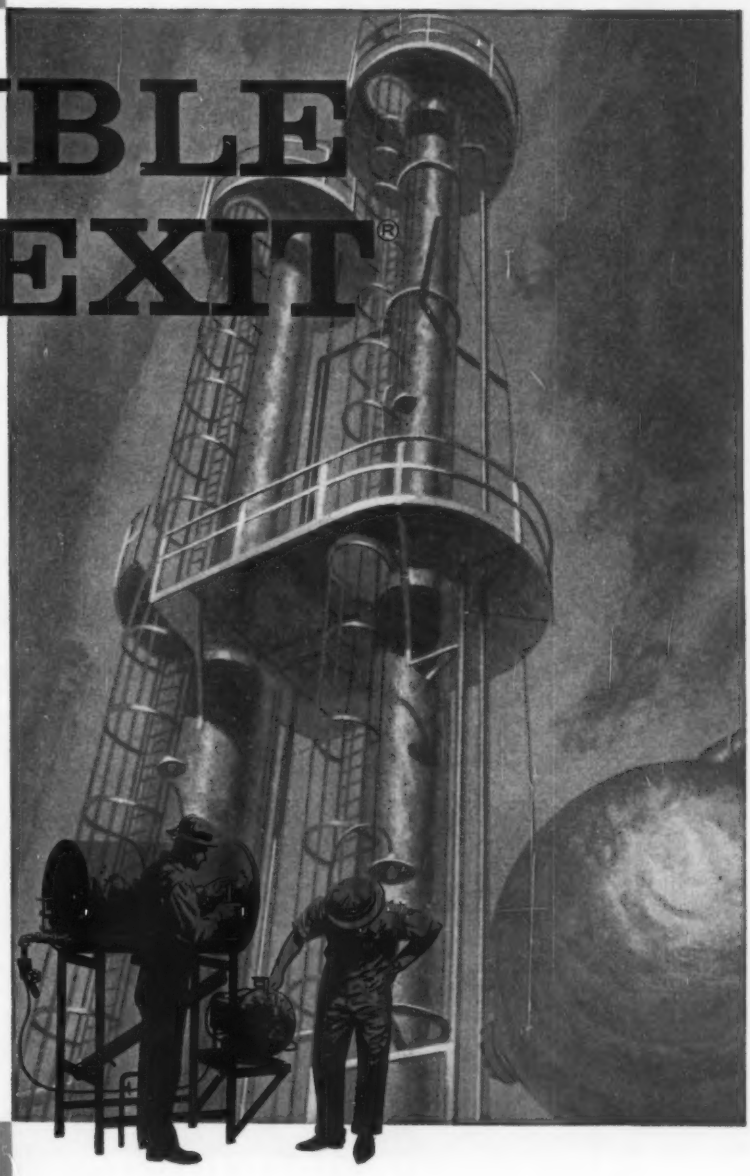


This 168' 9" Orthoflow converter, built by Newport News for Tidewater Oil Company's Delaware Refinery, south of Wilmington, Delaware, is the largest of its kind ever built.

Newport News
SHIPBUILDING AND DRY DOCK CO.
NEWPORT NEWS, VIRGINIA

98% protection* against internal corrosion

HUMBLE COREXIT®



* *Ten years of measurements* in refineries and gas plants prove its high efficiency and economy. For as little as 50¢ per thousand barrels of throughput, Humble COREXIT prevents internal corrosion in pipe still overhead, distillation towers, vapor recovery systems and other refining units. Equipment life is extended, you make longer runs between turn-arounds, and down time is reduced. *COREXIT makes important savings in every refinery and gas plant where it is used.* For complete information on technical services and COREXIT formulations to meet your specific requirements, see your Humble salesman or contact Humble Oil & Refining Company, Houston, Texas.

HUMBLE

America's Leading ENergy COmpany

For more data on advertised products, use cards, last page.

This picture symbolizes the cash savings to oil refiners that Canco's new light-weight can of double reduced plate makes possible. • These savings come from both lower initial cost and reduced shipping weights. • After complete testing, both in the laboratory and in the field, Canco backs the satisfactory performance of its new light-weight oil can with a full warranty.

Canco estimates new light-weight cans of double reduced plate will save the petroleum industry $3 million a year.

Most refiners are now ready to take advantage of this cost-reducing development. Are you ready?

Canco engineering and technical services—available through any of our sales offices—are ready to help you convert to new cost-reducing light-weight cans.

Per-case savings vary according to can specification. Total savings for the whole industry, however, could amount to more than $3,000,000 a year.

Completely researched and tested

The Steel Industry's recent perfection of double reduced plate first made these new light-weight cans possible. Canco Engineers spent months in intensive research adapting the new plate to an oil can of value. Before putting the can into full-scale production, they put it through every kind of test—both in the laboratory and in the field.

Backed by Canco's full warranty

These tests prove that the added strength of double reduced plate makes it a successful substitute for heavier-weight plate used in conventional oil cans. The strength of the new light-weight oil can is adequate for normal in-plant handling and subsequent distribution. Shelf life is equal to that of the regular can. Canco backs the satisfactory performance of its new light-weight oil can with a full warranty.

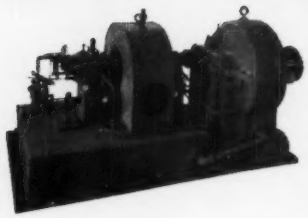
Full information is available from any Canco Sales Office.

CANCO Division **AMERICAN CAN COMPANY**

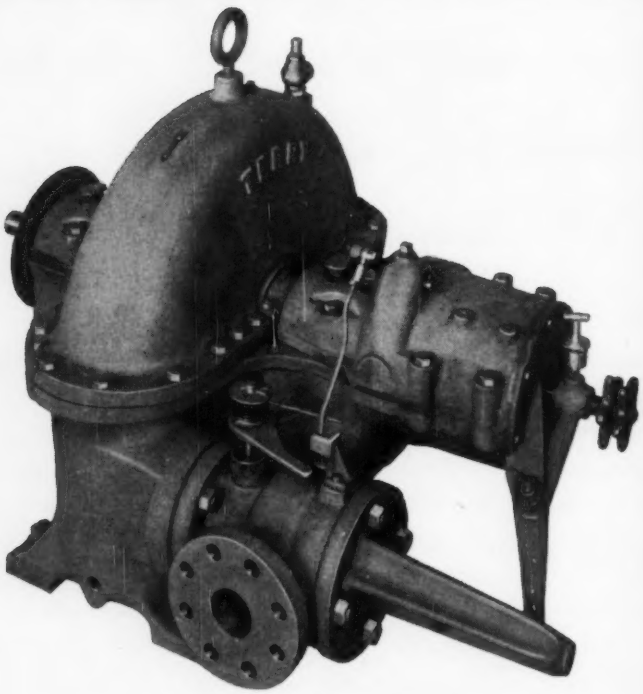
New York, Chicago, New Orleans, San Francisco

For more data on advertised products, use cards, last page.

There's a Terry solid-wheel turbine for any mechanical-drive requirement



Solid-wheel turbo-geared unit rated 600 hp, 4000/650 rpm.



Standard solid-wheel turbine with constant-speed mechanical-type governor and hand speed changer.

The completeness of the Terry line of solid-wheel turbines enables you to choose an *ideal* drive for any application . . . choose the specific features you want from a wide variety of designs.

Standard turbines are made in capacities up to 2,500 hp, with either cast-iron or cast-steel casings. The standard wheel is carbon steel. Where operation is to be at high speed or at high temperature, wheels of forged alloy steel are used. Vertical and geared turbines are also available.

And you can select from a range of governors, including: constant speed, either mechanical or oil relay, and variable speed, either direct acting or oil relay. Excess-pressure or constant-pressure pump governors are also available. When required, remote speed control can be furnished for variable-speed governors.

Tell us what your requirements are so we can send you full details of a turbine to meet your needs exactly. For general information, send for a copy of bulletin S-116.

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD 1, CONN.

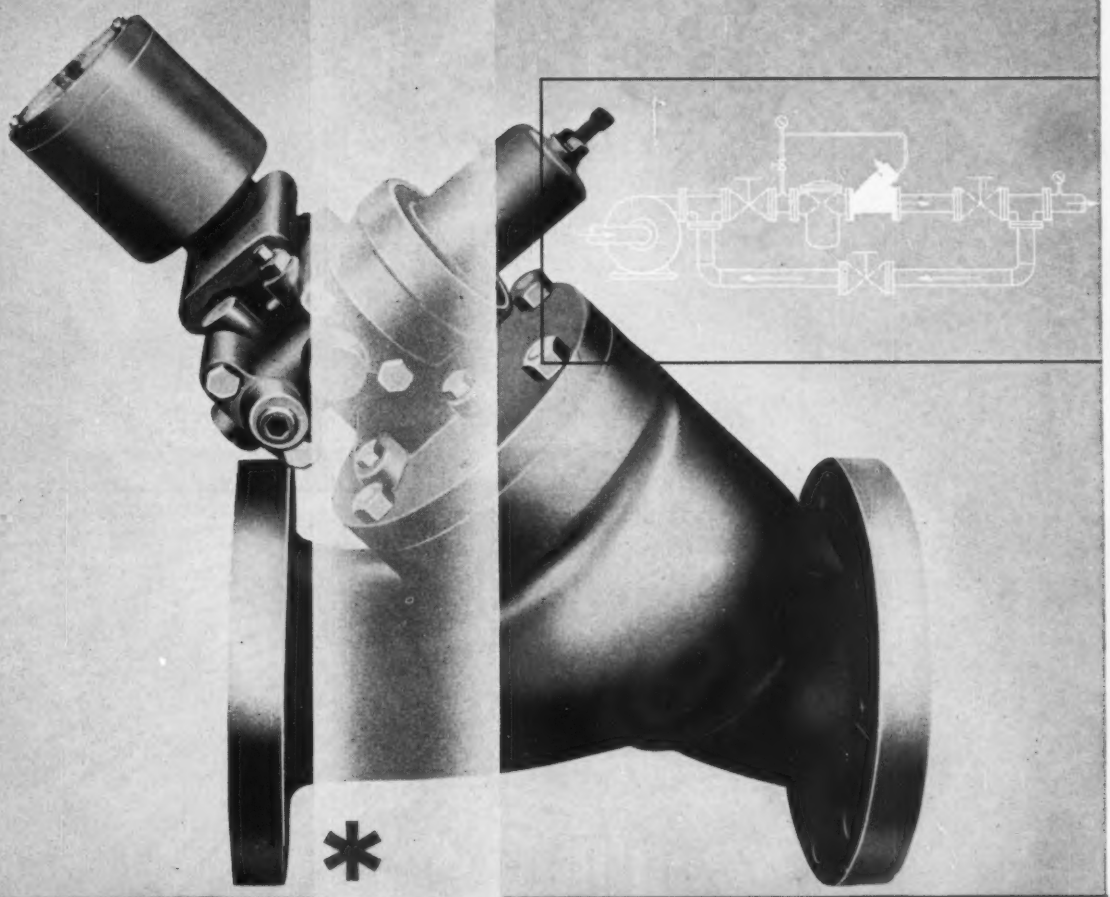
TERRY

Vertical turbines with the Terry solid wheel are available in capacities from 5 to 300 hp.

TT-1218

Complete Adaptability

You name the application * BRODIE Series 500 Control Valves are adaptable to fit it!



*

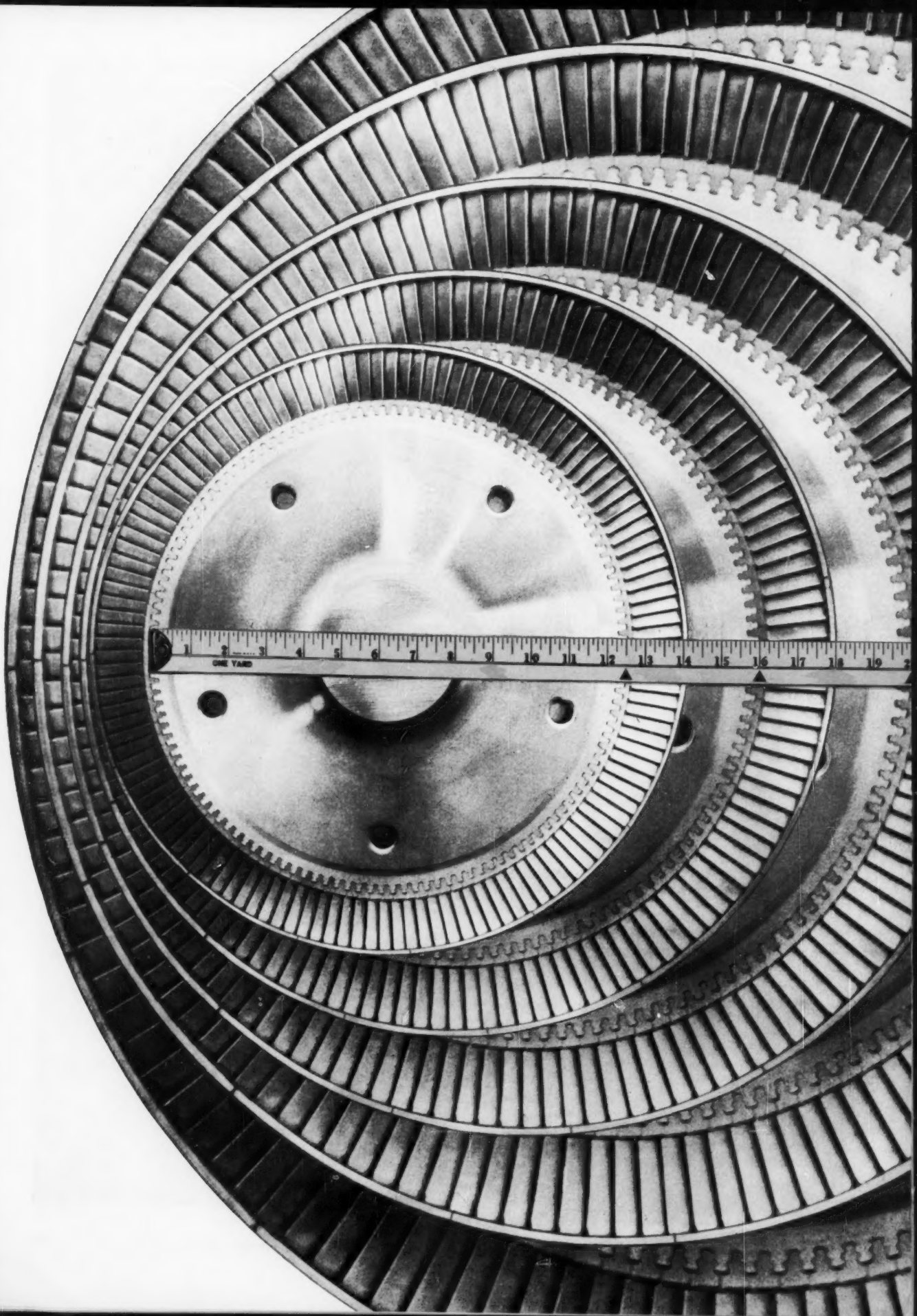
One valve does many jobs by simply changing pilots or adding multiple pilots, which are integrally mounted (**as shown above**). Smooth responsive control of extreme variations in flows and pressures with minimal pulsations is effected by **standardized** linear characteristics, large internal pilot valve ports, uniform rate of response. Self-contained internal parts, **including seat ring** are easily removed as a single cartridge unit. **For full details write for Bulletin 668, today.**

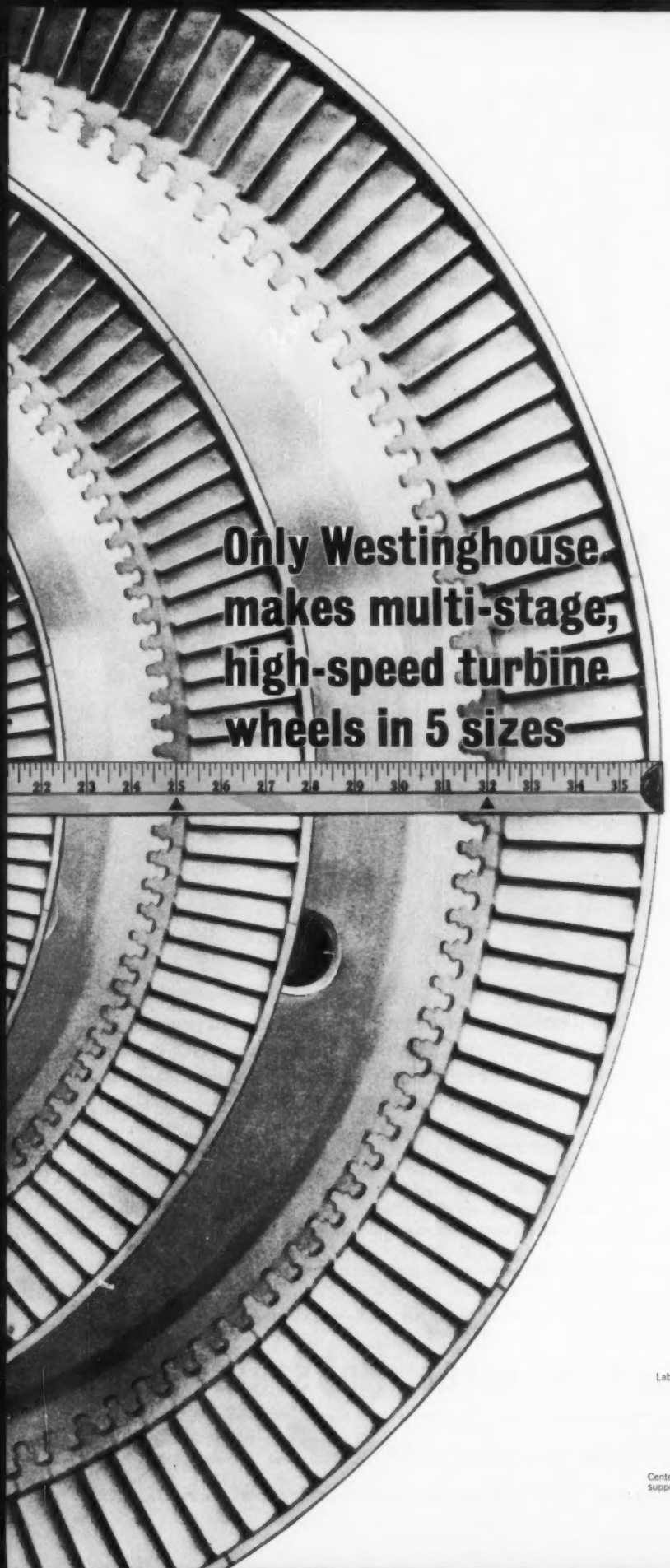
- Remote Control
- Diff. Pressure
- Rate of Flow
- Pressure Relief
- Pressure Regulation
- Surge Control
- Check Valve
- Thermal Pressure Relief
- Safety Shut-off

BRODIE
VALVES · METERS
RALPH N. BRODIE COMPANY
San Leandro, California, U.S.A.
CABLE ADDRESS: "BRODICO"
MT. VERNON, N.Y., 550 So. Columbus Ave.
DALLAS 7, TEXAS, 167 Parkhouse St.
SEATTLE 9, WASH., 221-9th Ave. N.
CHICAGO OFFICE: 1227 Circle Ave., Forest Park, Ill.
LOS ANGELES 22, CALIF., 5401 Sheila Street

REPRESENTATIVES WITH STOCKS AND SERVICE FACILITIES IN ALL PRINCIPAL CITIES

For more data on advertised products, use cards, last page.


ONE YARD



FOR THE RIGHT SIZE TURBINE START WITH THE RIGHT SIZE WHEEL

Several things determine what size turbine will supply power within economic limitations . . . steam pressure and temperature, exhaust steam pressure, horsepower and speed requirements, cost of steam, and operating hours required for turbine pay-out.

To bring all these factors into as close a relationship as possible, Westinghouse high-speed M-line turbines are custom-engineered for each job. Yet they all follow one basic assembly method, using standardized components. Result . . . the reliable performance expected from a *standard* design, combined with the high efficiency expected from a *custom* design.

Determining the right wheel size is the first and key decision . . . and only Westinghouse makes high-speed turbine wheels in 5 sizes, 12½ through 32 inches. This wide range makes Westinghouse M-line turbines adaptable to any steam condition and speed up to 16,000 rpm, with capacities up to 32,000 hp and higher.

Wheels are installed on one of five different size turbine frames, selected to match wheel sizes. Then, according to job requirements, other standardized components are selected and added to the assembly.

Westinghouse M-line turbines have a number of exclusive features, such as modular type governors and serrated root blading. Check these five other features. You'll find them on all high-speed M-line turbines built by Westinghouse . . . world's most modern small turbine facility.

Oil relay governor, with package components. Specifically designed for high-speed service.

Multi-valve bar lift steam chest. Liberal volume. Special valve and seat design for maximum part load efficiency.

Centerline support of casing. Eliminates thermal misalignment.

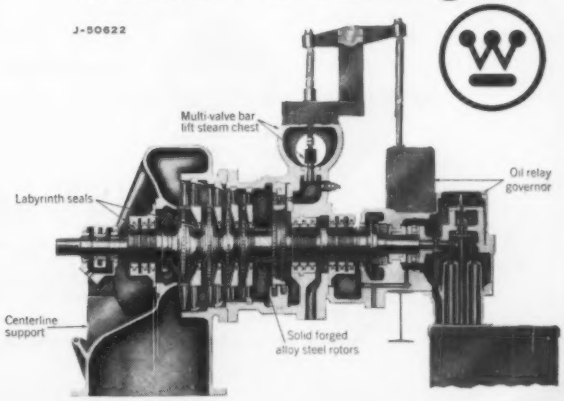
Solid forged alloy steel rotors for most applications. Critical speeds are well out of the operating range. Maximum operational dependability.

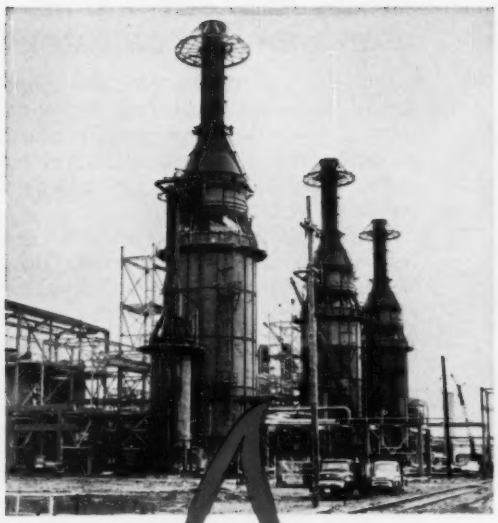
Labyrinth seals throughout. Eliminates maintenance and replacement required with rubbing type seals.

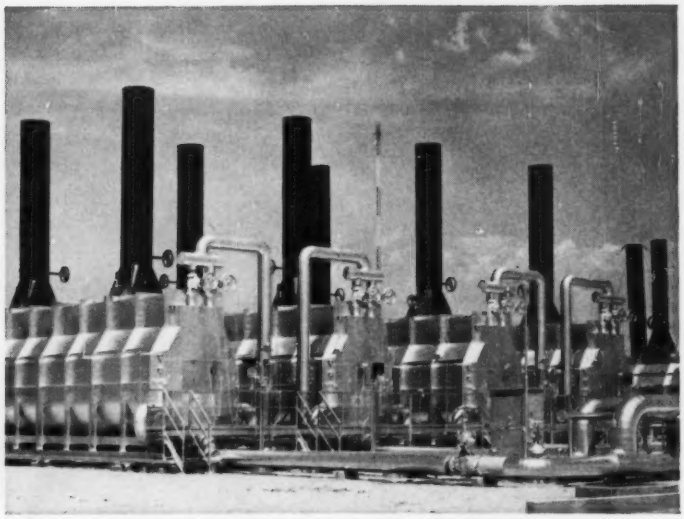
Send for new Descriptive Booklet B-8227 describing in detail the features of this new line of turbines. Write to Westinghouse Electric Corporation, P.O. Box 868, Pittsburgh 30, Pa.

You can be sure . . . if it's **Westinghouse**

J-50622







100,000 to 200,000,000 BTU

PETROCHEM VERTICAL AND HORIZONTAL DIRECT FIRED HEATERS

For the petroleum, chemical and petrochemical industries, Yuba now offers the most complete series of direct-fired heaters available. From 100,000 to 200,000,000 BTU per hour – from -200° to +2,000° F – Petrochem Vertical and Horizontal Heaters can be built in every size and type for every use in any location!

Yuba Heaters are available from the most simple horizontal design to the famous Petrochem vertical with optional reradiation cones for even heat distribution and maximum efficiency.

Working closely with both customer and prime contractor, Yuba can provide single piece, shop-assembled horizontal heaters *to 30,000,000 BTU*. Other heaters up to 50,000,000 BTU can be provided in two sections. For field installations of larger heaters, Yuba can provide well-trained supervisory personnel when desired. Get the complete story on Petrochem direct-fired heaters from Yuba – your largest single, fully-integrated source of supply.

Other Yuba Products For The Petroleum, Chemical and Petrochemical Industries—Adsco Expansion Joints, Transaire Air-Cooled Heat Exchangers, Shell and Tube Heat Exchangers, Southwest Floating Roof Tanks, Cone Roof Tanks, Pressure Vessels, Field Erection, Columns and Towers, Process Condensers, Custom Fabrication.

YUBA

specialists in process heaters—every size, capacity and duty

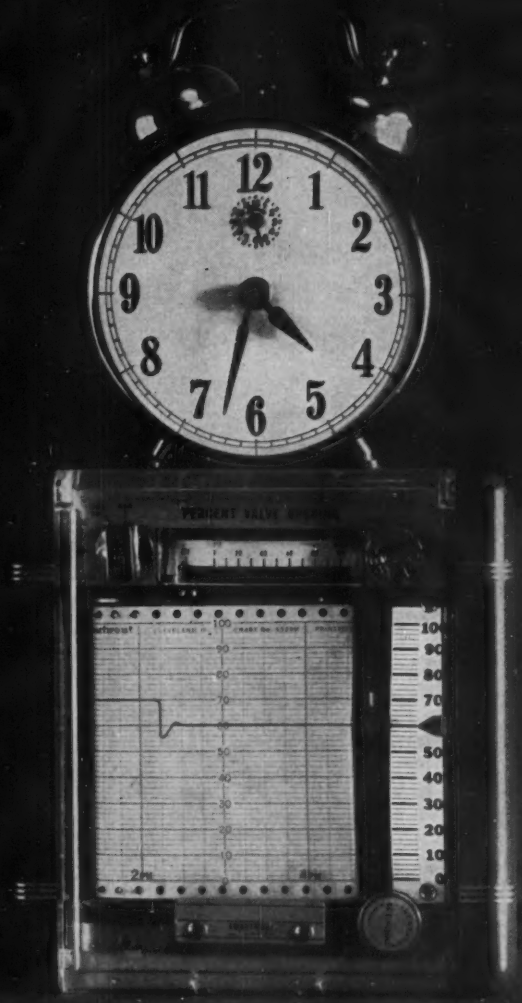
YUBA HEAT TRANSFER CORPORATION

Tulsa, Oklahoma

YUBA CONSOLIDATED INDUSTRIES, INC.

Sales Offices in Chicago • Houston • Los Angeles • New York • Pittsburgh • San Francisco

INTERNATIONAL LICENSEES: Birwelco Ltd., Birmingham, England (United Kingdom, British Commonwealth). Heurty Italiana, S.P.A., Milan, Italy. Societe Anonyme Heurty, Paris, France. Societe Anonyme Belge Heurty, Liege, Belgium. Fujinagata Shipbuilding Ltd., Osaka, Japan.



654 MILLION HOURS ON-STREAM; NO TIME OFF FOR MISBEHAVIOR

Ten years ago, the first Autronic® loop went on-stream. It has since been joined by more than 20,000 others. These loops have rolled up 654 million service-hours, measuring, indicating, recording, and controlling every conceivable process variable.

In all that time, very few have required more than token service—the change of a circuit card, a screwdriver calibration adjustment, that's all.

There's good reason for this successful record: Swartwout people are thoroughly oriented to electronic control. They know its advantages. They know its pitfalls, too . . and how to avoid them.

If you are considering making your next control loops electronic (and most people are), Swartwout's unique experience, backed by the most complete selection of equipment in the industry, can assure on-stream success.

More information? Send for Bulletin A-913.

SWARTWOUT

SWARTWOUT DIVISION, CRANE CO.

HOOKSETT INDUSTRIAL PARK • MANCHESTER, NEW HAMPSHIRE

SWARTWOUT . . . World Leader in Electronic Process Control

moving fast with CRANE

WHEREVER STREAM BLENDING IS INVOLVED

Automatic stream blending is our business . . . whether it be a simple two component system or a multicomponent system for blending gasolines, jet fuels, solvents, lube oils, waxes, residual fuels or asphalts. Performance-proved Proportioneers blending systems are designed by men who recognize a problem and dare to pioneer new concepts. With 30 years of field application and manufacturing experience, B-I-F offers the petroleum industry the most comprehensive source of stream blending data available.

Through constant research in continuous processing, B-I-F has developed a wide line of compatible system components. From this line, B-I-F can custom-build a stream blending system to accommodate your most exacting specifications at minimum cost.

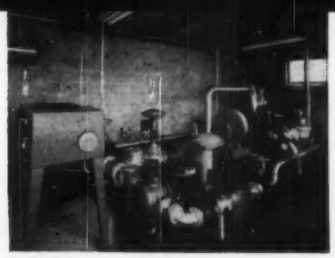
Continuous automatic blending systems offer greater operational flexibility, provide tailor-made end products on the spot, reduce intermediate tankage and end product storage. If you have a blending problem, find out how a B-I-F engineered system can add more profit to your operation! Write **B-I-F Industries, Inc. 412 Harris Avenue, Providence 1, Rhode Island.**

Industries

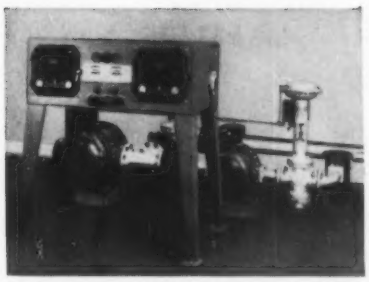
BUILDERS-PROVIDENCE • PROPORTIONEERS • OMEGA

METERS • FEEDERS • CONTROLS / CONTINUOUS PROCESS ENGINEERING

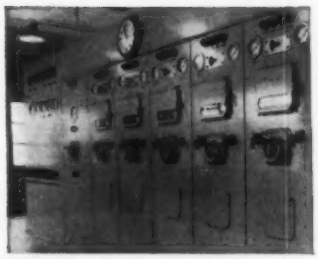
FIRST . . . IN MEASUREMENT AND CONTROL OF MATERIALS FLOW



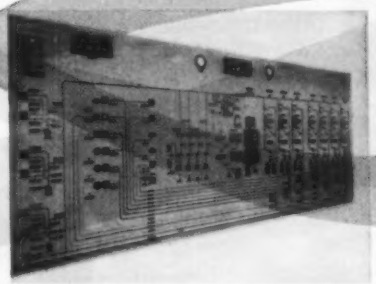
FUEL OIL Base stocks at terminals or loading racks are blended at twist of a dial . . . directly from storage to tank trucks, tank cars or barges . . . automatically, safely, accurately!



ASPHALT Penetration blends or asphalt cutbacks are continuously blended in a single-pass operation at loading racks direct to tank truck without intermediate storage and within state specification.

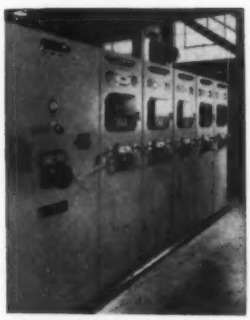


LUBE OIL Continuous recirculation-type fail-safe Panel Blenders . . . compound specification lubes and additives at minimum production costs . . . increase operating efficiency and formulation accuracy . . . reduce tankage.

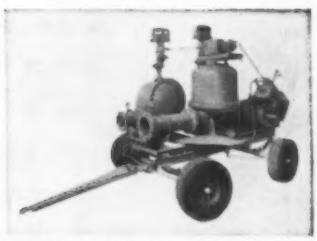


GASOLINE Explosion-proof Panel Blenders, close-coupled or remote, continuously proportion base stocks, dyes, additives, and TEL with fingertip control over any formulation in any quantity. Error-free, fail-safe operation.

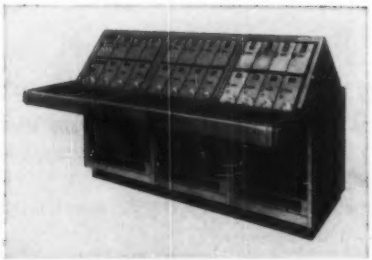
ADDITIVES A complete line for automatically proportioning additives to gasoline, lubricating oils, fuels, etc.; including economical proportioning pumps and flow responsive metering systems.



JET FUEL Automatic in-line Panel Blender . . . remote transmission . . . minimum installation cost, maximum flexibility, high accuracy, economical fingertip formulation.



BUNKER FUEL Mobile units . . . for continuous, automatic, "on-the-spot" blending of specification bunker fuels directly from base stock storage to ships' bunkers.

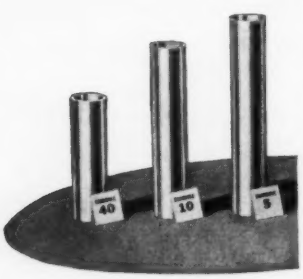


ELECTRONIC BLENDING In multicomponent blending systems, the B-I-F Electronic Console provides remote operation with maximum control in minimum space at minimum cost. Entire blending operation, supervised by a single qualified technician, effectively provides "Laboratory Control" of entire operation. Is applicable in the gasoline, lube oil and jet fuel operations illustrated above.

YOU NAME IT! When it comes to stream blending, a B-I-F specialist is ready to recommend and furnish estimates. See Thomas Register or Chemical Engineering Catalog for your nearest B-I-F representative.

REAL ECONOMY IN PROCESS PIPING IS A MATTER OF SPECIFICATIONS—AND SPEEDLINE FITTINGS!

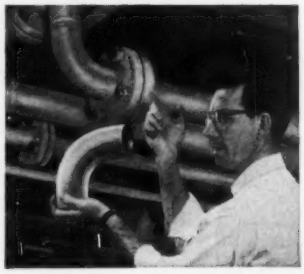
Make the most of both. First, be sure to check ASA B31.3 for up-to-date pressure-temperature data on critical process applications. This most recent issue of the Code for Pressure Piping certifies the use of light-wall pipe and fittings to a degree not recognized by outdated specifications.



SPECIFY LIGHT-WALL PIPE and get up to 50% more pipe for your dollar

Next, consider the installation advantages of Speedline's improved fittings design to capitalize on light-wall piping savings. Note Speedline's "tangential feature" . . . the extra length of straight on every end of every Speedline Fitting. This extra clearance eliminates alignment problems and speeds welding . . . permits joints to be readily butt-welded, flanged, or socket-welded. You choose the most practical, cost-saving joining method for your application—and one fitting can be used all ways when you specify Speedline Fittings.

Compute total savings in terms of initial costs *and* ultimate *installed* costs. Light-wall pipe and fittings, of course, cost less to begin with because they use less metal. Speedline versatility, however, adds *extra* savings in installation time and labor costs that further reduce final installed costs.



SPECIFY SPEEDLINE FITTINGS and reduce installed piping costs to a minimum

Piping standards have changed. It will pay you to be up-to-date with light-wall specifications that call for Speedline Fittings. Get details from your nearby Speedline Distributor today. He's listed on page 1494 of Chemical Engineering Catalog.

Speedline®

CORROSION-RESISTANT FITTINGS

STAINLESS STEEL • ALUMINUM • NICKEL
OTHER ALLOYS ON APPLICATION

300

A PRODUCT OF **HORACE T. POTTS COMPANY** • 566 E. ERIE AVENUE, PHILADELPHIA 34, PA.

acts fast: There are times when a valve must shut off NOW! That's why you'll find Rockwell-Nordstrom valves in critical operations everywhere. With their smooth, fast quarter turn action and positive shut-off they're man's best friend in an emergency. It makes a lot of sense to use these same Rockwell-Nordstrom valves in all services—they cost no more. We'll be happy to send you complete information.

ROCKWELL-Nordstrom VALVES
another fine product by
ROCKWELL

Write to:
Rockwell Manufacturing Company
95-F N. Lexington Ave.,
Pittsburgh 8, Pa.
Canadian Valve Licensee:
Peacock Brothers, Ltd.
Box 1040, Montreal, Quebec
Rockwell International, S.A.
81 Rue de la Servette
Geneva, Switzerland

Please send me Bulletin V-217.

Name_____

Company_____

Street_____

City_____ Zone____ State____

NEW

low-cost,
high-potency
fuel oil additive

polyflo 120™

***See your PSE**

Correct selection and most effective use of petroleum inhibitors and additives involves expert analysis and consideration of many factors. As specialists for over a quarter-century, UOP is able to provide unparalleled field service, brought to you by a member of our staff of Product Sales Engineers*. For detailed information on the UOP family of superior inhibitors and additives call or write our Products Department.

- Especially suitable for treating

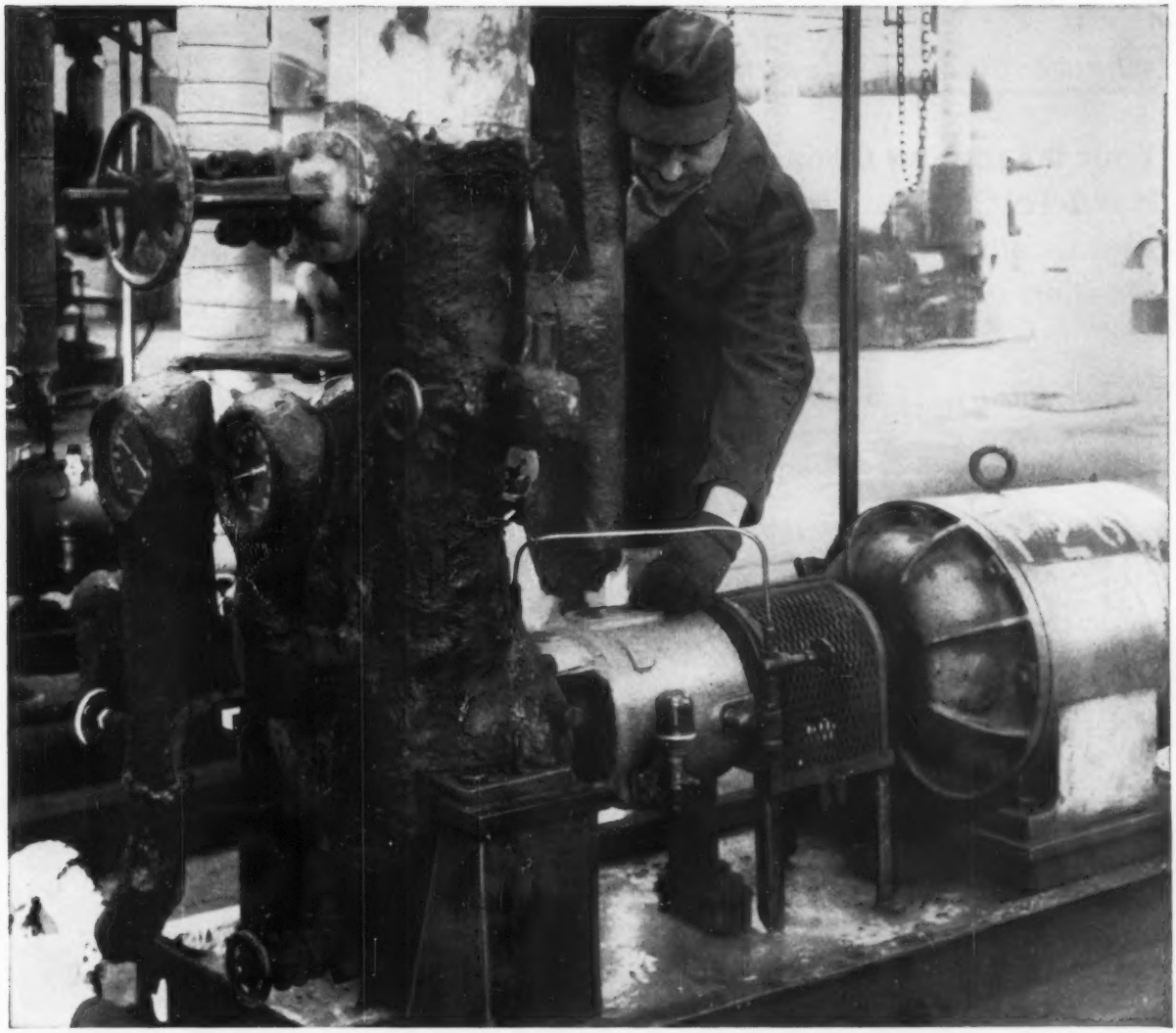
  No. 2 HEATING OIL and DIESEL FUEL BLENDS

- Maintains fuel oil stability through seasonal storage—even in high summer heat
- Highly effective as color stabilizer—sediment inhibitor—anti-emulsion agent
- Enhances action of other additives, such as copper deactivator
- *Treatment costs only one-fourth to one-half cent per barrel of product.*

Write for information and samples. Address our Products Department.

UOP®

UNIVERSAL OIL PRODUCTS COMPANY
30 Algonquin Road, Des Plaines, Illinois, U.S.A.
WHERE RESEARCH TODAY MEANS PROGRESS TOMORROW



NI-RESIST CASING BEATS GRAPHITIC CORROSION

After 3 years of refinery service, cooling-water pump still going strong

"Our regular castings failed back in 1957 after only three years' service. You could almost put your finger through the casing," said Walter R. Maxwell, Mechanical Engineering Assistant. He was describing the cast iron casing of a centrifugal pump at The Atlantic Refining Company's crude-fractionating unit (Philadelphia).

Costly graphitic corrosion necessitated repair to a pump handling steam condensate and river water at a rate of 3000-5000 bbl/day at 100°F. The water has a pH of 5.5-6.5.

Type 1b Ni-Resist*, containing 15% nickel, replaced the cast iron more than 3 years ago. Result? To date, no replacement of casing; no corrosion-caused downtime.

Ni-Resist irons rarely show graphitic corrosion because of their inherent resistance to most corrosives—and because they contain reduced amounts of free carbon. Easily cast and readily machined, the Ni-Resist irons show excellent resistance to cavitation erosion, wear, and heat.

How the Ni-Resist irons may lower your costs for valves and piping, too, is described in *Engineering Properties and Applications of Ni-Resist Irons.* To have the facts at your finger tips, send for this free 70-page booklet today.

*Registered trademark

WHAT ENGINEERS SHOULD KNOW ABOUT GRAPHITIC CORROSION

Exposed to certain corrosive environments, cast iron suffers graphitization: it loses much of its ferrite; a coating rich in carbides remains.

Graphitized Coating may accelerate the corrosion of the cast iron base.

Accelerated Corrosion Rate may occur when a cast iron part bearing a graphitized coating makes contact with an uncoated part.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street INCO New York 5, N. Y.

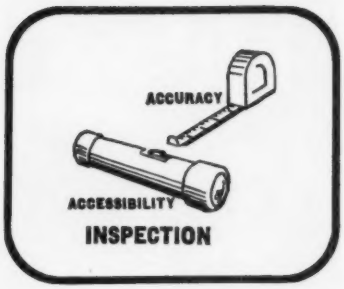
NI-RESIST

NICKEL MAKES CASTINGS PERFORM BETTER LONGER

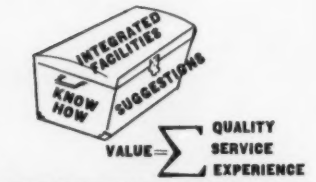
For more data on advertised products, use cards, last page.

When evaluating a product—

Your Inspection Department Should Not Have To Compromise On Workmanship And Quality in the Interest of a Vendor's Meeting a Shipping Date . . .

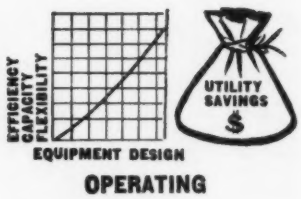


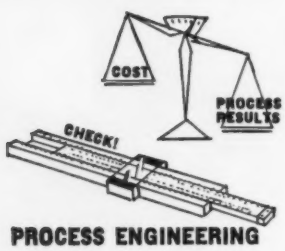
Glitsch Quality, Plus Glitsch Cooperation, Make Compromising Unnecessary—

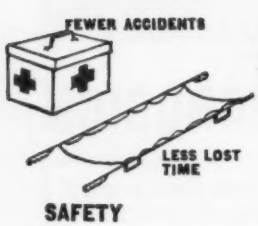


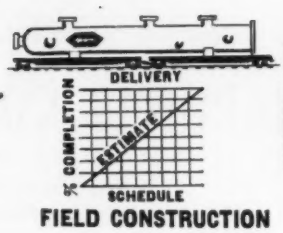
Glitsch pricing of custom fabrication or Glitsch products take into consideration pride-of-workmanship and the quality of appearance of the end product.

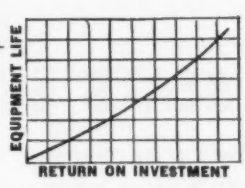
It is realized by Glitsch that "short cuts" that lead to poor quality are not in the best interests of our customers or the ultimate users of our products.











PRODUCTS — Glitsch Lightweight "Truss-Type" Ballast Trays, Sieve, Bubble Cap, Dualflow, Disc, Donut, Accumulator, and Mist Eliminator Trays . . . Pressure Vessels, Contactors, Reactors, Filters, Heat Exchangers, and Other Specialty Products . . . Bubble Cap and Riser Assemblies, Flanged and Dished Heads, Machine Time, Stampings, Knitted Wire and Woven Wire Screen.

TECHNICAL — **Fractionating Tray Engineering:** Process, Mechanical, Structural, and Metallurgical Designing. **Pressure Vessel Engineering:** Pressure, Temperature, Wind, Earthquake, and Dynamic Designing. **Special Product Engineering:** Research and Development and Model Mock-Up. **Special Tooling and Machine Design** for Specific Purposes and Problems.

Glitsch
SINGLE ENGINEERING RESPONSIBILITY

FRITZ W. GLITSCH & SONS, INC.

General Offices and Manufacturing Plant: 4900 Singleton Boulevard, Dallas

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NEW CALSILITE-HI® HANDLES SOAKING 1800°F

Light, strong and economical, new Calsilite-Hi is ideal for both insulation and fireproofing where temperatures run over 1250°F up to 1800°F. For lower temperatures than these, Ruberoid's Regular Calsilite® insulation is recommended.

Both Calsilite and new Calsilite-Hi are molded calcium silicate insulation. They're light and easy to install. They cut and mitre quickly, smoothly. They're gentle on hands. They stay strong when wet, won't soften or fall off, return to original thermal efficiency when dry. They resist most industrial chemicals and alkalies. Available in half sectional, three segmental and block form.

For additional information, specifications, and free samples of new Calsilite-Hi or regular Calsilite insulation, mail coupon now.

RUBEROID®

Industrial Insulation Division PR-6
The RUBEROID Co.
500 Fifth Avenue
New York 36, N. Y.

☐ Please send technical bulletin with specifications
☐ Please send sample of Calsilite-Hi
☐ Please send sample of regular Calsilite

Name_____

Title_____

Company_____

Address_____

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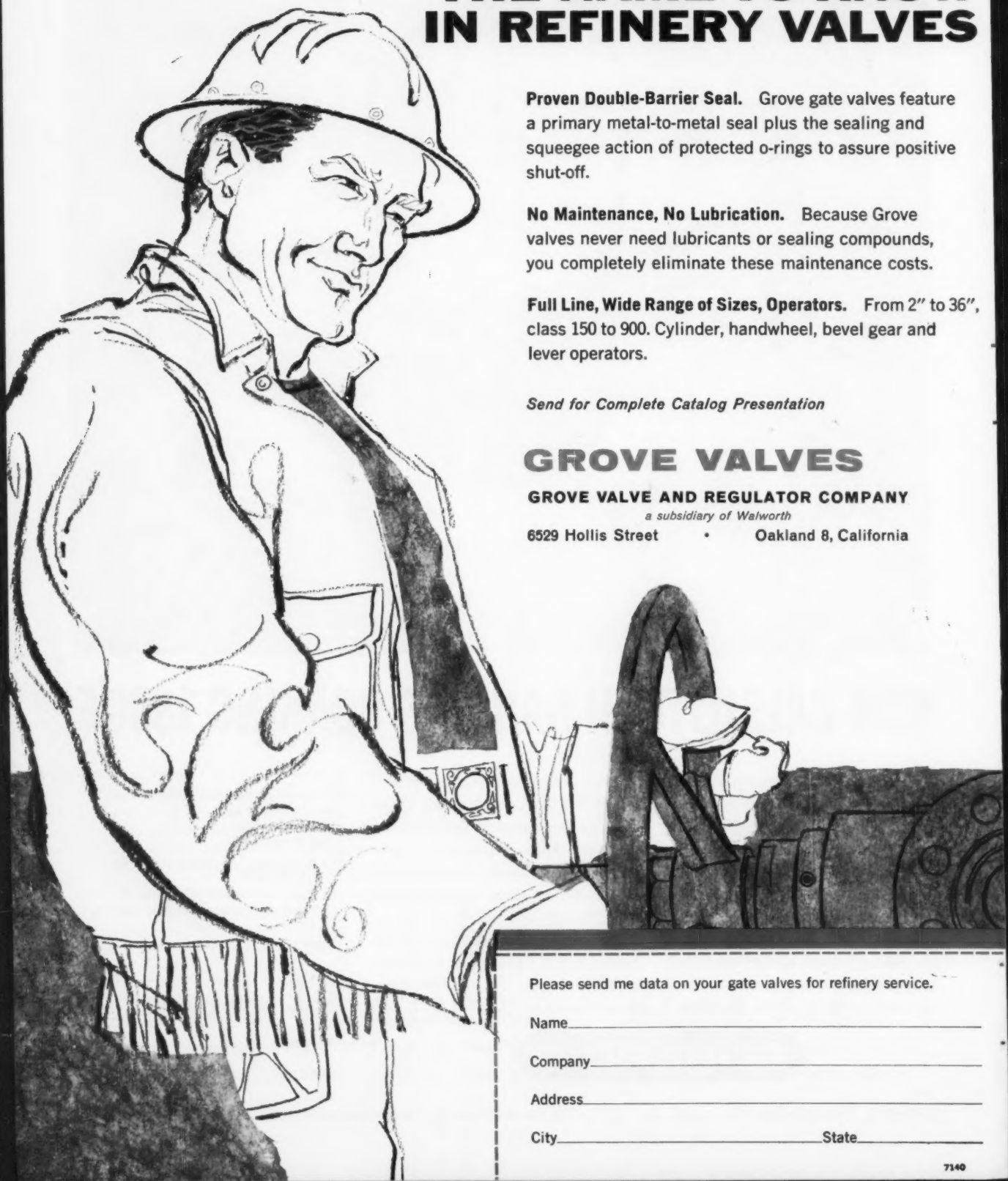
For more data on advertised products, use cards, last page.

GROVE

THE NAME TO KNOW IN REFINERY VALVES



Proven Double-Barrier Seal. Grove gate valves feature a primary metal-to-metal seal plus the sealing and squeegee action of protected o-rings to assure positive shut-off.

No Maintenance, No Lubrication. Because Grove valves never need lubricants or sealing compounds, you completely eliminate these maintenance costs.

Full Line, Wide Range of Sizes, Operators. From 2" to 36", class 150 to 900. Cylinder, handwheel, bevel gear and lever operators.

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GROVE VALVES

GROVE VALVE AND REGULATOR COMPANY

a subsidiary of Walworth

6529 Hollis Street • Oakland 8, California

Please send me data on your gate valves for refinery service.

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Company_____

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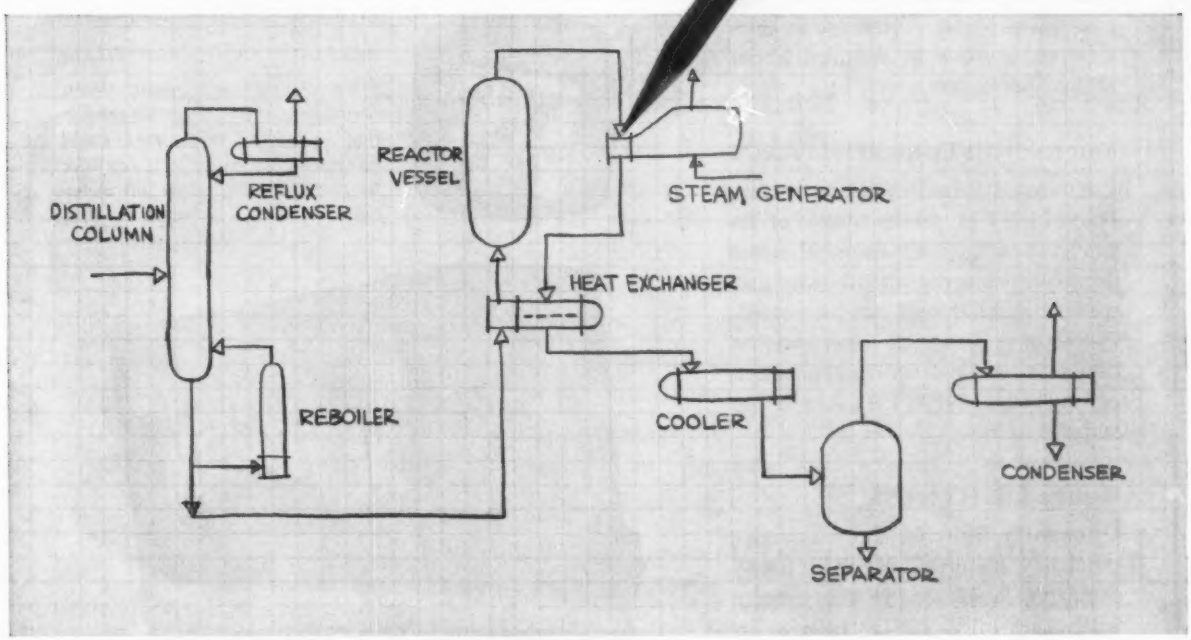
when you plan your process...

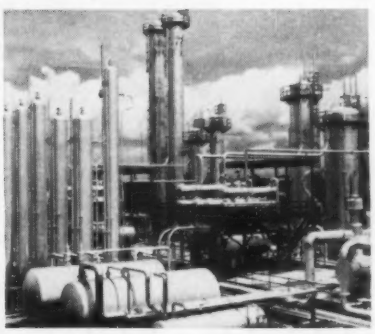
plan on A. O. Smith

for custom-built pressure vessels, heat exchangers and related products



Plan on A. O. Smith for your process equipment—and plan with confidence. A. O. Smith has the facilities and know-how to custom-tailor process equipment to your exact specifications. A world-recognized leader in the process equipment field, A. O. Smith can provide quality-built components to satisfy any process requirement.

However, building modern process equipment is only part of the A. O. Smith plan. Also available to you is the industry's most respected staff of research scientists, technicians and engineers who will help you analyze your operating conditions and make suitable recommendations backed by long experience.



Many modern process plants have a complete range of A. O. Smith custom-built equipment, such as: heat exchangers • reboilers • evaporators • condensers • coolers • columns • hydraulic cylinders • air storage vessels • reactors • autoclaves • tanks.

Plan to call on your nearest A. O. Smith office. Or send for our new brochure, "From Arc to Atom." Write Dept. 0113-PR, A. O. Smith Corporation, Milwaukee 1, Wis.

Through research ... a better way

A.O.Smith
CORPORATION

ATOMIC AND PROCESS EQUIPMENT DIVISION
Milwaukee 1, Wisconsin

For more data on advertised products, use cards, last page.

take NEWTHERM on test!

Test its STRENGTH

NEWTHERM is unusually strong and rigid—a feature of special importance in the larger, more vulnerable sections. Put a sample section or slab on part of your plant and *prove for yourself* its outstanding ability to withstand impact and water damage. See how it withstands rough handling in transit and erection, minimising breakage in shipment and erection by unskilled labour at the most remote sites.

Test its MOISTURE RESISTANCE

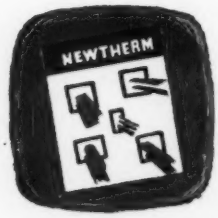
Even totally immersed in water, NEWTHERM retains much of its strength and rigidity. It does not become deformed when in contact with water, thus work-in-progress need not be covered. Especially on contracts where weather conditions would delay the application of insulation—NEWTHERM is the material to use.

Test its LIGHTNESS

Unusually light for such a high-efficiency material, NEWTHERM compares favourably in this respect with other insulants far inferior in strength. That means easier handling and fewer breakages—even the largest section is easily carried in one hand.

Test its EASE OF APPLICATION

Undoubtedly, NEWTHERM is one of the easiest of materials to apply. It is supplied in plastic form and in a wide range of standard-sized sections and slabs, smoothly finished and straight edged for immediate fitting. The finished job is very neat, with minimum joints, and appliers particularly appreciate the handleability of the material—especially in difficult situations.



READ ALL ABOUT NEWTHERM

in a specially prepared booklet. Sizes, compressive strength, thermal conductivity,—this and much more useful information can be on file if you write for your copy now, to the sole manufacturers Newalls Insulation Co. Ltd.

NEWALLS (Reg'd Brand)

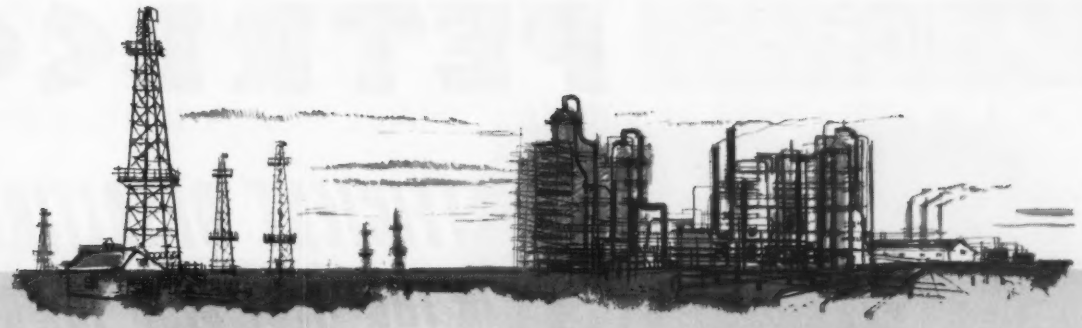
***NEWTHERM** calcium silicate insulation*

. . . for temperatures up to 1400°F.

NEWALLS INSULATION CO. LTD.

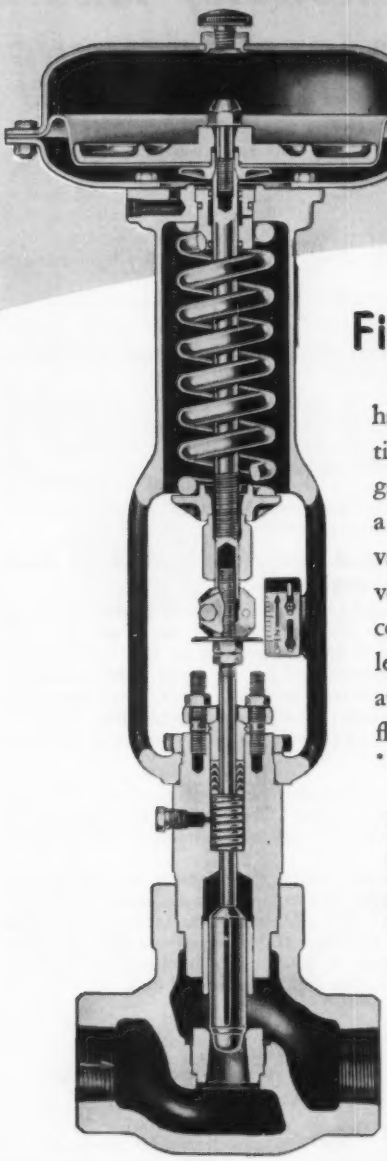
Head Office: WASHINGTON, CO. DURHAM, ENGLAND.
A member of the TURNER & NEWALL ORGANISATION
Offices & Depots at: LONDON, GLASGOW, MANCHESTER, NEWCASTLE UPON TYNE, BIRMINGHAM, BELFAST, DUBLIN, BRISTOL & CARDIFF.
Agents and Vendors in most markets abroad.

59



NO WHIPPING... NO VIBRATION...

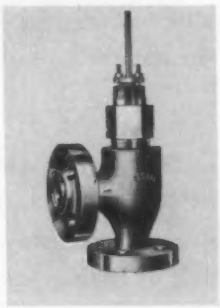
under high pressure drop conditions



Fisher High Pressure Cast Steel "D" Bodies

There's good reason why Fisher "D" bodies have become a standard item in oil and gas production control, and are also widely used in power plant, gas distribution and process industries. Here are just a few: The exclusive Fisher Micro-form Pup inner valve with rigid heavy duty extension guiding prevents whipping or vibration even under highest drop conditions. All "D" bodies are furnished with stainless steel trim and Stellite* on the seating surfaces at *no extra charge.* Can be supplied with screwed, flanged, socket or butt welding ends.

* Registered TM—HAYNES STELLITE



NOW AVAILABLE WITH INTEGRALLY CAST FLANGES

DESIGN "D" AND "DA" BODY AND ORIFICE SIZES

Size, Inches	Body End Connection	Body Pattern	Maximum Working Pressure	Orifice Size, Inches
½, ¾	Screwed	"D" Globe	3600 psi	¼, ⅜, ½
1				¼, ⅜, ½, ¾
1½, 2				¼, ⅜, ½, ¾, 1
1	1500 lb. ASA Flanged			¼, ⅜, ½, ¾
2				¼, ⅜, ½, ¾, 1
1	Screwed or 2500 lb. ASA Flanged	"D" Globe	6000 psi	¼, ⅜, ½, ¾
2*				¼, ⅜, ½, ¾, 1
1	Screwed or 1500 lb. ASA Flanged	"DA" Angle	3600 psi	¼, ⅜, ½, ¾
2				¼, ⅜, ½, ¾, 1
1	Screwed or 2500 lb. ASA Flanged	"DA" Angle	6000 psi	¼, ⅜, ½, ¾
2*				¼, ⅜, ½, ¾, 1

*Also available with 5,000 lb. and 10,000 lb. API flanges.

TYPE 667-D

Write today for further information

IF IT FLOWS THROUGH PIPE ANYWHERE IN THE WORLD... CHANCES ARE IT'S CONTROLLED BY...

FISHER GOVERNOR COMPANY

Marshalltown, Iowa / Woodstock, Ontario / Rochester, England

BUTTERFLY VALVE DIVISION: CONTINENTAL EQUIP. CO., CORAOPOLIS, PA.

FISHER® Controls

SINCE 1880

For more data on advertised products, use cards, last page.

PRODUCT IMPROVEMENT WITH

PETRECO

EFFICIENT DESALTING is the first step towards PROFITABLE REFINING

Salt removal is now a routine operation in all modern refineries. With the need for effective desalting widely recognized, the main problem today is the selection of that equipment which will do the most efficient job at the least possible cost.

When you need new or additional desalting facilities, keep these points in mind:

■ ***The first electric desalter was designed and installed by Petreco engineers.***

This was nearly a quarter of a century ago. The subsequent years of solid, practical experience in dealing with (and solving) desalting problems all over the world now enable Petreco desalting to yield salt removals in the 98-100% range. The fraction of a cent per barrel desalting cost is saved many times over by the gains in refining efficiency resulting from a clean charging crude.

■ ***The first chemical desalter was designed and developed by Tretolite engineers.***

Tretolite chemical formulations were the first ever to be used in desalting. Tretolite desalting units are the only exclusively chemical desalters ever to be sold and installed in the refining industry and are currently used to desalt a million and a half barrels per day. In fact, every important development in crude oil desalting has resulted from the Petrolite research, engineering and development program.

YOU GET

98-100% SALT REMOVAL

WITH PETRECO ELECTRIC OR

TRETOLITE CHEMICAL DESALTING

Because Petreco offers both kinds of desalters, the company has no "axe to grind". This means that you get an honest and objective appraisal of the method best suited to your operation.

There is no other desalting equipment on the market today that can offer you comparable efficiency of design. The operating records from installations around the world *prove* it! There's no other company, either, that can offer you Petreco's fund of desalting technology or Petreco's rich background in this highly specialized field.

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1390 East Burnett Street (P.O. Box 7216), Long Beach 7, California

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NEW TEMPERATURE TRANSMITTER

offers thermal system options with ranges from −125° to 1000°F

New Temperature Transmitter is available with concentric scale as shown or as a non-indicator. The unit transmits with calibrated accuracy of ±0.5% of full scale, and indicates within ±1.0% of full scale.

Completely new, completely flexible, the new Honeywell Temperature Transmitter gives you a choice of either gas or mercury thermal system plus a wide selection of measuring bulb styles. Die-cast aluminum case is 4″ by 7″ by 9″. Concentric scale is 8½″ long.

New built-in rebalancing capsule automatically compensates for changes in ambient temperature. Two-way overload protection covers 100% of span. Maintenance is greatly simplified by modular construction which lets you remove any major component by loosening two screws. All field adjustments are easily accessible, and a self-locking feature prevents upset after calibration adjustments are made.

Transmitter Features: Gas (—125° to 800°F) and mercury (—40° to 1000°F) actuated thermal systems with bulbs for any application. Mount on pipe welded to flow line, or on bracket that clamps on the hex head of the socket. Vibration resistant thermal system means accurate measurement on vibrating flow lines.

For more complete details on the new Temperature Transmitter, call your nearby Honeywell field engineer. Or write for *S630-1*. MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa. In Canada, write Honeywell Controls, Ltd., Toronto 17, Ontario.

Honeywell

First in Control

SINCE 1885

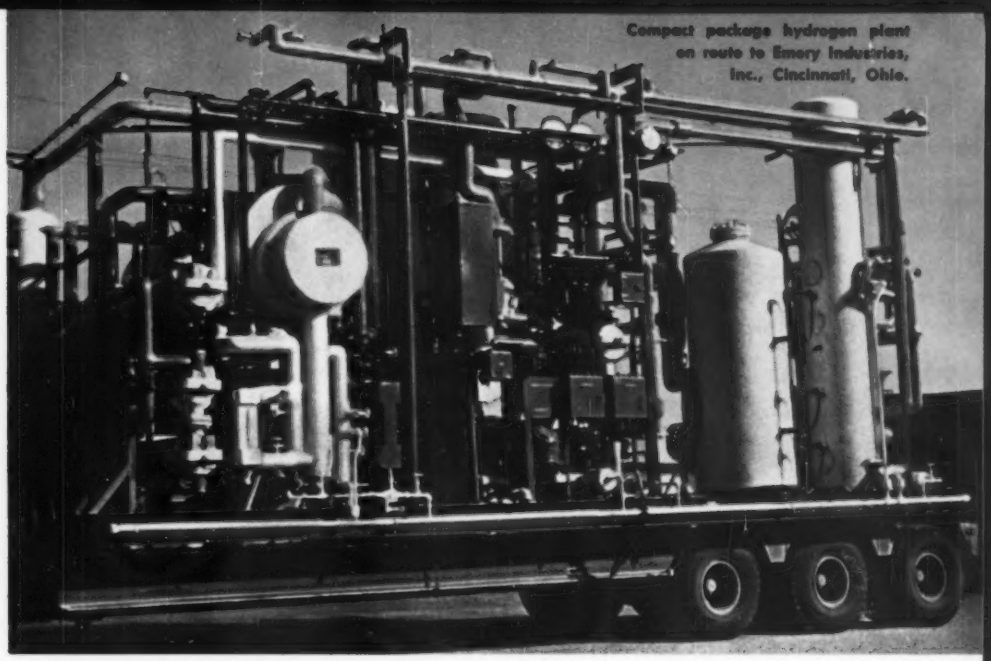
HONEYWELL INTERNATIONAL Sales and Service offices in all principal cities of the world. Manufacturing in United States, United Kingdom, Canada, Netherlands, Germany, France, Japan.

GIRDLER

builds them large and

300 ton-per-day ammonia plant at Mississippi Chemical Corporation, Yazoo City, Miss.

small



Compact package hydrogen plant on route to Emery Industries, Inc., Cincinnati, Ohio.

For the Chemical, Petrochemical and Petroleum Industries

What are your requirements? Regardless of the size of your operation, there is a Girdler process and plant designed and constructed with capacities to meet your specific needs. Both Girdler site-erected and compact package plants now in operation throughout the world are achieving great success for their users. You should consult Girdler for your Chemical and Petrochemical process and plant requirements.

GIRDLER PLANTS AND PROCESSES

HYDROGEN	MEISSNER NITRATION PLANTS	AMMONIA
HYDROGEN SULFIDE	HYDROGEN CYANIDE	DRY ICE
OXO SYNTHESIS GAS	AMMONIA SYNTHESIS GAS	NITRIC ACID
GAS PURIFICATION	AMMONIUM NITRATE	UREA
CARBON MONOXIDE	HYDROGEN CHLORIDE	CARBON DIOXIDE
SULFUR RECOVERY	PHOSPHORIC ACID	FERTILIZER
FORMALDEHYDE	SULFURIC ACID CONCENTRATION *(Plinke Process)*	PHOSGENE
		GAS DEHYDRATION

PACKAGE PLANTS FOR PRODUCING:

HYDROGEN	HYDROGEN SULFIDE	SULFUR RECOVERY
CARBON DIOXIDE	GIRBOTOL GAS PURIFICATION	HYDROGEN CYANIDE
		HYDROGEN CHLORIDE

GIRDLER

CORPORATION / LOUISVILLE 1, KY.

SUBSIDIARY OF THE CHEMICAL & INDUSTRIAL CORP.

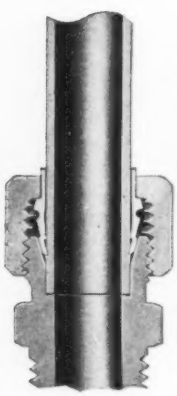
THESE PARKER TUBE FITTINGS MEET YOUR EXACT NEEDS

Processing demands specific fittings— not a "general" type

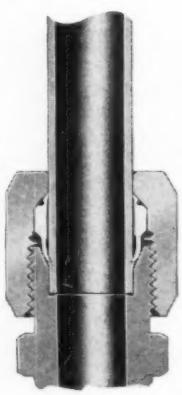
Parker covers *every* specific processing application with a fitting built for the job. There's inexpensive "Intru-lok" for instrument air . . . husky "Ferulok" for high pressures in steel and stainless steel. Both are positive, bite-type fittings. For complete corrosion resistance, new "Ridg-lok" is 100% of type 316 stainless.

Where flared tubing is used, the Parker 37° "Triple-lok" is the acknowledged leader, available in any practical metal.

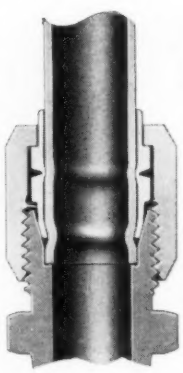
For extreme temperature conditions at any pressure, "Weld-lok" combines ease of assembly and streamlined flow. "Braze-lok" withstands somewhat less heat, but is even easier to assemble and can be disassembled when necessary.



FOR INSTRUMENT AIR, use "Intru-lok®" brass and aluminum tube fittings with the captive ferrule you can't lose. For copper, aluminum, Nylon and "Parker-POL" polyethylene tubing. Simple, compact, easy to install, inexpensive. Ask for Catalog No. 4324.

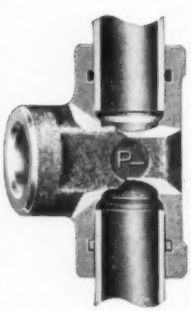


HIGH PRESSURES require "Ferulok®" heavy-duty flareless fittings with the visible bite that lets you make sure you have safe make-up. Usable with heavy-wall tubing. Excellent vibration resistance. Stocked in steel, stainless steel; available in Monel. Ask for Catalog No. 4320.

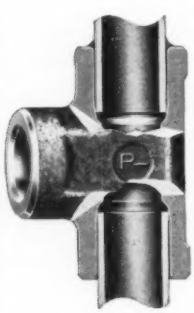


COMPLETELY CORROSION RESISTANT "Ridglok" fittings are all stainless steel (type 316). Unique ferrule design provides safe, dependable non-flare grip. Ferrule "foolproof" —identical ends make it impossible to put in backwards. Ask for Catalog No. 4322A.

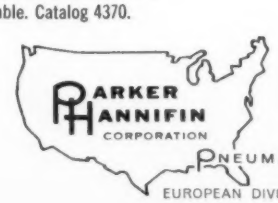
BRAZED JOINTS can be used where there isn't room to swing a wrench. They give you a permanent joint, yet one that can be taken apart and re-used. You just apply heat, either to make or break the joint. Parker "Braze-lok®" is completely reliable for high pressures at temperatures up to 500° F. Steel, stainless steel, Monel and cupro-nickel. Catalog 4375.



WELD WITH Parker "Weld-lok®" whenever a permanent joint will best serve your purpose . . . when the process is hazardous, when temperatures or pressures are extreme, when vibration is a problem. "Weld-lok's" socket design makes assembly easy. Steel and stainless steel in stock; aluminum available. Catalog 4370.



Complete specifications and engineering help are available from your nearby Parker distributor. Find him through the Yellow Pages, or write us direct.



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PNEUMATIC AND HYDRAULIC SYSTEM COMPONENTS
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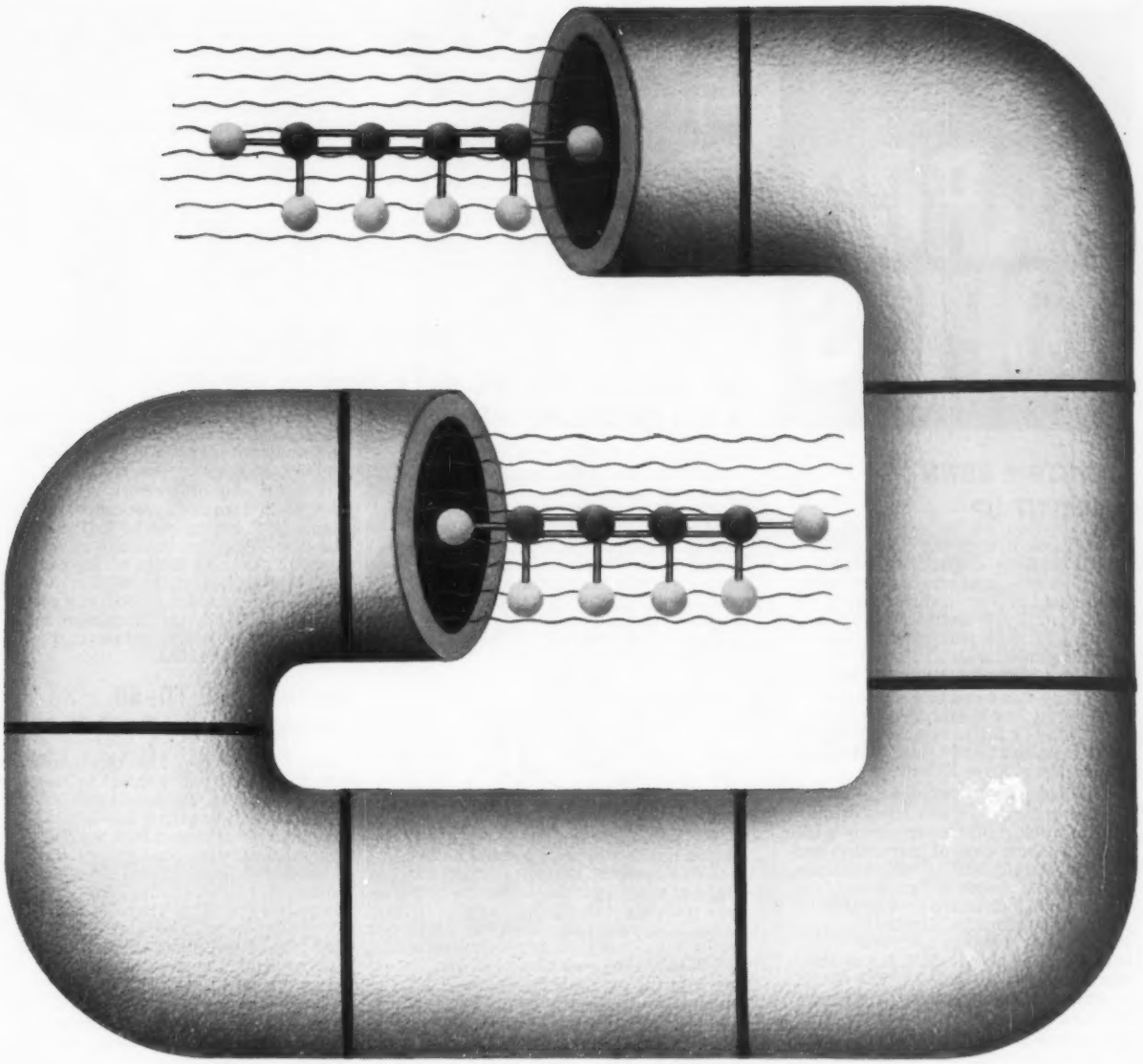


Mean Mean Temperature

Parsimony pays, when you are dealing with
costly heat. Where relatively slight
temperature drop in piped liquids is critical,
Caposite moulded insulation makes a valuable difference.
Caposite pure Amosite Asbestos is a heat miser.
It is tough, permanent, easy to fix,
light in weight and low in cost.

CAPOSITE AMOSITE ASBESTOS INSULATION

Enquiries to: **Cape Insulation and Asbestos Products Ltd.** *(A Subsidiary of The Cape Asbestos Co. Ltd.)*
114 & 116 Park Street, London, W.1. Telephone: GROsvenor 6022. Cables: Incorrupt London

or to: Cape Asbestos (Canada) Ltd. 200 Bloor St. East, Toronto, Ontario.
Capamianto SpA via Sant' Antonino 57, Turin, Italy.

TAE465

For more data on advertised products, use cards, last page.

ONE OF A SERIES OF CHATS ABOUT THE CONSERVATION AND CONTROL OF HEAT

SARCO TOPICS

DOWNTIME DOWN —OUTPUT UP

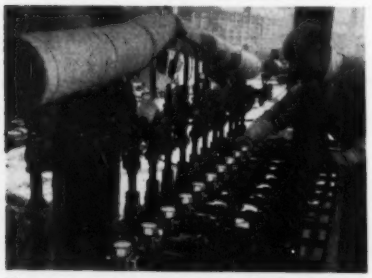
Continuous processing . . . two big words in the world of petroleum processing . . . and one big headache when the line has to shut down unexpectedly. It's not just the pure pain in the neck that mechanical failure produces. It's the costs that keep mounting during downtime.

Let's face it, no one can eliminate every bug. But steam trap failure is a bug there's no excuse for. Not since Sarco created the Thermo-Dynamic Steam Trap, Type TD-50.

For one thing, TD-50's hardly know the meaning of the word downtime. For another, maintenance people like them for their ease of inspection and service. And TD-50's don't require high quality steam to function. Reichhold Chemical's new Maleic Anhydride plant in Elizabeth, New Jersey, for example, has standardized on TD-50's, for these very reasons. Of their 320 TD-50's, most are in service on 35-lb. steam tracer lines.

How come it's so trouble-free? Because it's simple, with only one moving part. Its performance is uniform; it operates equally well on heavy, light, or no condensate load—even against back pressures up to 50% of inlet pressure. It's so rugged that superheat, water hammer, vibration, or corrosive condensate won't affect it. If you should ever want to service a TD-50, a highly unlikely prospect, you can unscrew the cap, clean it, blow it down, and have it back on stream in 40 seconds.

You ask how it works? Aha! That's another story that goes back over 200 years, and what better place to tell it than right here, in the section that follows.



The character pretending to inspect one of Reichhold's TD-50's is Sarco's ad manager, who normally wears a gray flannel suit. We're happy to see strainers used properly on this 14-trap manifold to protect the steam traps, even if they don't happen to be Sarco strainers.

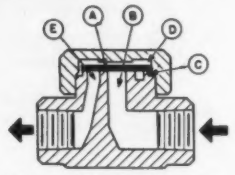
MR. BERNOULLI HELPS BUILD A BETTER STEAM TRAP

We may be a trifle tardy in bringing it up, but Daniel Bernoulli, who dreamed up the "Bernoulli Effect" about 250 years ago, deserves some sort of accolade from us here at Sarco. A plaque perhaps, or his name in the foyer floor tile. Daniel was a famous Swiss mathematical genius and he was probably a little hesitant about even mentioning his slightly offbeat discovery, the "Effect," in *Hydrodynamica* (1738).

If you happen to have a spool handy, you can perform the simple "effect" right at your desk. Lay a cardboard disc with a pin through it on the table. Place the spool over the pin and blow—hard—and lift. The disc won't fall until you stop blowing because the air under pressure expands between the end of the spool and the disc. The pressure in this space is actually less than atmospheric, and the sum of the downward forces is less than the upward force of atmospheric pressure acting upon the disc's bottom side.

Well, of course it *sounds* rather remote, but what seemed like a simple parlor trick to Bernoulli has made it possible for us at Sarco to solve steam trapping problems by the dozens. In our Sarco Thermo-Dynamic Steam Trap, Type TD-50, the cardboard disc is replaced by a stainless steel disc A, the spool tube by inlet tube B. The disc also acts as a valve and can seat on B, and also on outer seat ring C. When seated, the disc seals the inlet and the chamber D from the outlet E.

Full attention now, because it could easily be *your* steam, condensate, or air we're following here as it enters the trap, its pressure raising the disc and allowing fluid to flow radially across the underside of the disc. The velocity of air or condensate is comparatively low, exerting little influence on the disc, which remains



clear of the seat, allowing free discharge. Ah, but now steam enters the trap. Velocity increases greatly because of the steam's greater internal energy. Presto! The disc is pulled toward the seat just as was the cardboard. At the same time, the radial steam jet raises the pressure in D by recompression, snapping the disc down on the seat.

Downward force of recompressed steam in F, acting on the full area of the disc, is greater than the upward force of the inlet steam acting on the smaller area of the inlet orifice. So the disc remains seated, stopping all flow of steam, until pressure in D is reduced by condensation, and the cycle is repeated.

BEYOND THE TD-50 PRINCIPLE

Surprise! In spite of the one-track subject matter you've had the decency to ingest so far, we manufacture a good deal more than TD-50's. As a matter of proud fact, we are the only company that makes and sells all five types of steam traps. After all, there is a place for Balanced Pressure Thermostatic, Float Thermostatic, Camlift Bucket, and Liquid Expansion Thermostatic Steam Traps too. And our knowledgeable engineers can tell you exactly where to use what—and how.

And may we modestly add, that's only the beginning? As long as our present conversation seems to consist of product name dropping, we'll just mention the fact that we make exceptionally fine pressure and temperature regulators of rather astonishing variety and ingenuity. For example, we have a complete line of self-powered regulators for heating and cooling. And to make most effective use of these last few lines—strainers of all kinds—even hand and motor operated scraper strainer types. We could fill this page with lists of applications, testimonials, and specifications, but it would be eminently more sensible simply to say: Tell us your problem.

Write us direct, or contact your local Sarco sales representative or sales office.

Pardon our monopolizing the conversation in this series of paid communiques, but we're trying our best to interest you in certain subjects that concern us both—to the point where you'll communicate. 6816

SARCO

SARCO COMPANY, INC.
635 MADISON AVENUE, NEW YORK 22, N. Y.
PLANT: BETHLEHEM, PA.

STEAM TRAPS • TEMPERATURE CONTROLLERS
STRAINERS • HEATING SPECIALTIES

NEW

G-R *Pre-Engineered* STANDARDIZED COMPONENT SHELL and TUBE *Heat Exchangers*

Outstanding Purchaser Advantages:

1. Proven construction reflecting many years experience in designing and fabricating custom shell and tube exchangers for the Petroleum, Petrochemical, Chemical and allied industries.

2. Elimination of custom engineering charges.

3. Less costly than custom designed exchangers, permitting a *smaller* appropriation to buy *more* plant facilities.

4. Certified final dimensioned drawings furnished with the quotation.

5. Approval of drawings given with the purchase order, minimizing drafting and transmittal time.

6. Piping layout and support structures can be started without delay.

7. Dome design and port location assure maximum operating efficiency.

8. Maximum tube counts by computer calculation minimize fluid by-pass.

9. Adequate inventories and partial pre-fabrication speed delivery.

10. Full compliance with ASME and TEMA-R Codes, whichever is most exacting, plus G-R quality control.

11. Wide range of shell sizes, surfaces, and pressures to meet all but the most unusual requirements.

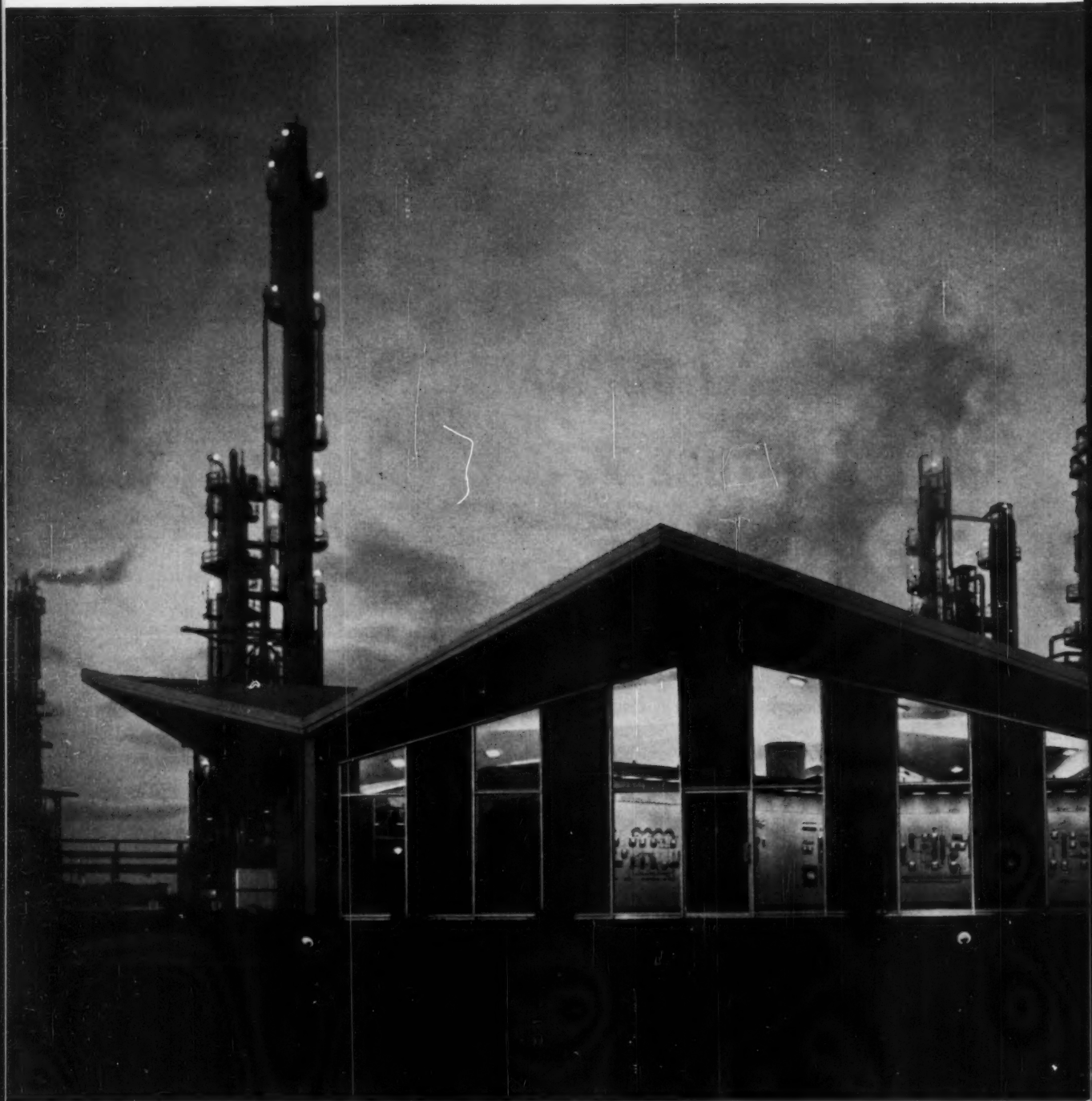
12. Acceptable modifications from standard construction provide the flexibility of custom design in meeting individual specifications of large operators.

Get Full Details! Send for your copy of Bulletin No. 101 Today!

Griscom-Russell

THE GRISCOM-RUSSELL COMPANY
222 Wetmore Ave. Massillon, Ohio Telephone TE 2-8751
Engineering and Sales Representatives in the Principal Cities

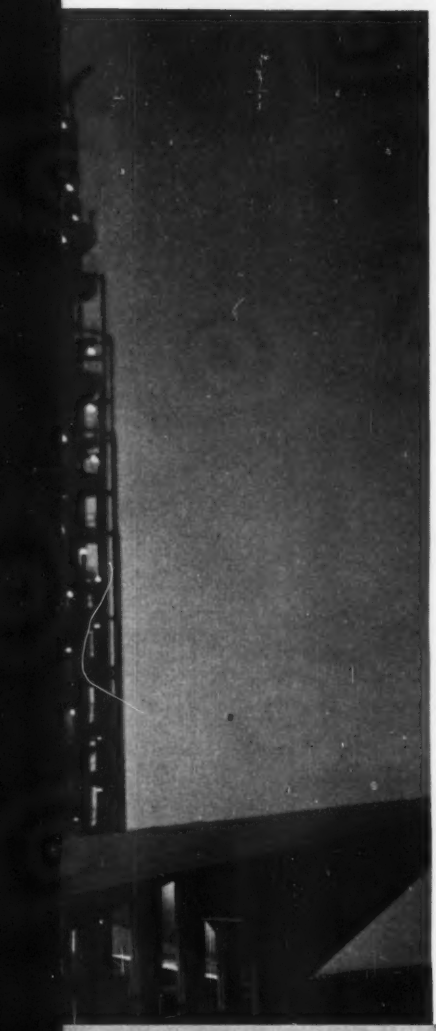
Foxboro pneumatic control huge Canadian



Photography by John K. Harris

THREE FOXBORO CONTROL PANELS for Imperial's Chemical Products Cracking Unit are housed in this unique hexagonally-shaped control room. Panels, which are arranged in a star-shaped pattern, contain 178 Consotrol recorders and controllers. Panels were built by The Foxboro Company, Limited, Montreal.

installed at Refinery and Petrochemical Plant



Imperial Oil's giant Sarnia Plant counts on Foxboro Consotrol* instruments for accurate, dependable control

From its star-shaped control room to its towering columns, they've used the most advanced refining techniques at Imperial Oil's 94,000 barrel-per-day refinery at Sarnia, Ontario.

Little wonder that accurate, dependable, low-maintenance Foxboro Consotrol instruments were installed. For example, clay treating, cracking and fractionation, ethylene recovery, butadiene extraction, refrigeration, light ends, Hydrofining, Powerforming, debutanizing, detergent alkylation, and production of Naptha Specialties — all operate under Foxboro control.

Actually, you'll find Foxboro small-case pneumatic consotrols serving leading refineries wherever reliable instrument performance is a must. If you're not familiar with the Consotrol story, ask your nearby Foxboro Field Engineer for full details. Or write for Bulletin 13-18. The Foxboro Company, 746 Neponset Avenue, Foxboro, Massachusetts.

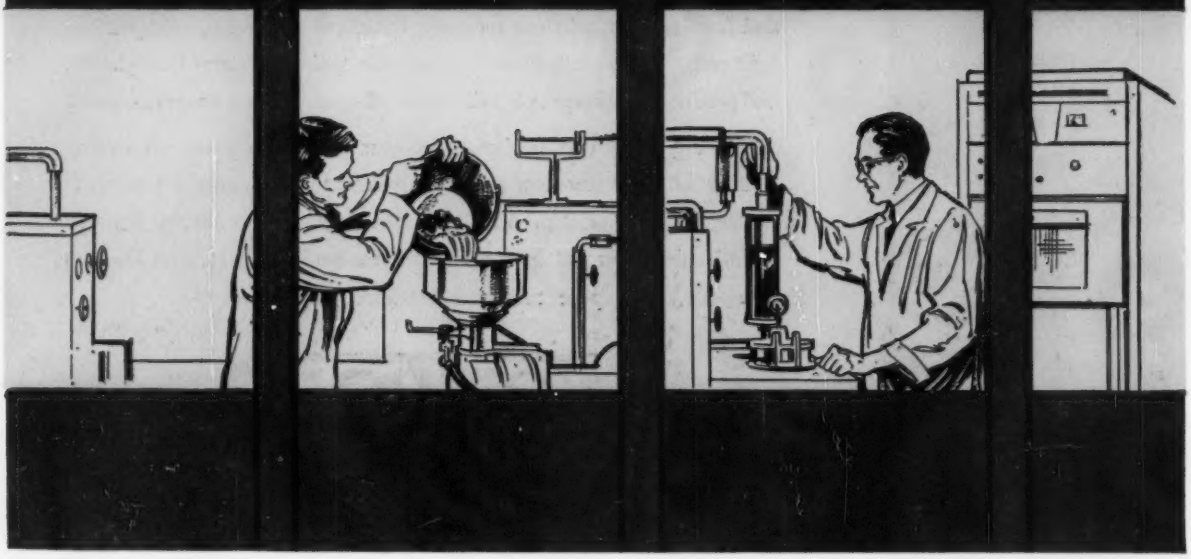
Reg. U. S. Pat. Off.

FOXBORO
REG. U. S. PAT. OFF.

THESE FOXBORO CONSOTROL PANELS are installed in the Powerformer Unit Control Room.

BONUS FOR ALKALI USERS...

synergized technical service from fmc®



The new wing at our Princeton Research Center houses the combined application research staffs of all FMC Inorganic Chemical Divisions.

Working there as an integrated team, their over-all capabilities are vastly multiplied. They have the newest equipment to reproduce many of the important basic processing operations used in the industries we serve. And they are closely supported by our superbly equipped analytical-research groups.

This modern, customer-service laboratory is another FMC activity designed to help you use our products more effectively and economically. It supplements the valuable assistance rendered in customers' plants by engineers, technicians and industry specialists working out of our plants, offices and laboratories.

Remember this outstanding service the next time you have a problem involving alkalis. And next time you're in the market for alkalis, remember FMC.

CAUSTIC SODA 50% and 73% Liquid, Regular and Rayon Grades; Flake, Solid and Ground
CAUSTIC POTASH 45% and 50% Liquid; Flake **SODA ASH** Light, Intermediate and Dense Grades

Putting Ideas to Work

FOOD MACHINERY AND CHEMICAL CORPORATION

Chlor-Alkali Division

General Sales Offices:
161 E. 42nd STREET, NEW YORK 17

"We deliver too"

What's so special about the huge fractionating tower shown here? It is one more example of how Sun Ship builds and delivers heavy industrial equipment on barges or sea-going vessels, with careful attention to such requirements as safety and on-time schedule.

Whether it's a fractionating tower or key structural part for industry, transporting big items by water or by rail is strictly routine for Sun Ship, for we build and deliver what's needed in many fields. If you have a machinery or heavy equipment problem, write to us about it.

Sun

SHIPBUILDING & DRY DOCK COMPANY

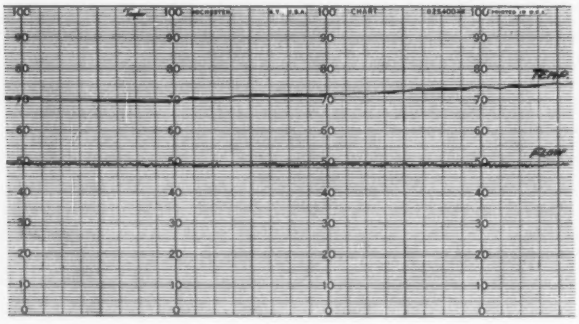
ON THE DELAWARE • SINCE 1916 • CHESTER, PA.

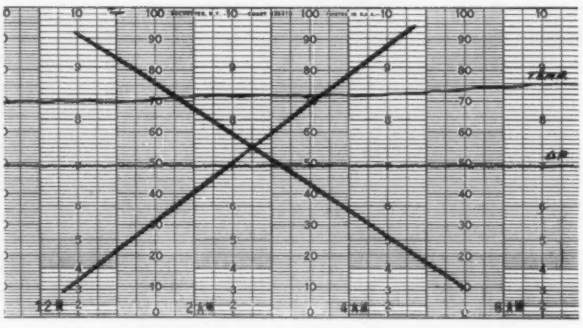
For more data on advertised products, use cards, last page.

NEW FROM

212T TRANSCOPE® Indicating Flow and DP Transmitter

Now . . . calibration linear with flow obsoletes sectionalized charts





SPECIFICATIONS

Range Interval: *continuously adjustable 20" to 250" w.g.*

Accuracy of Calibration: (*Referred to input*)—*Transmitter* ½%.

Static Rating: *1500 psi.*

Overrange: *Can accept full static pressure overrange, reverse or direct.*

Case: *Sturdy, die-cast aluminum, for field mounting.*

Primary Materials: *Carbon steel or Type 316 S.S. Flanges and adaptors with Type 316 S.S. trim.*

Taylor Instruments

Taylor

The only DP transmitter that can be calibrated for output linear* with flow as well as differential pressure without changing parts

Really a "transmitter with a built-in computer", the No. 212T TRANSCOPE Force-Balance Flow and Differential Pressure Transmitter can be converted from linear with flow to linear with differential pressure (liquid level) simply by calibration. It employs a liquid-filled, diaphragm sealed primary unit and a unique secondary unit in which force balance is accomplished by a powerful motion servo and spring combination. Servo power makes possible these features, unavailable in conventional transmitters:

- Ratio and cascade control without intermediate, separate square root extraction.
- Simple analog computations involving flow and other variables pneumatically without an extra "black box".
- Elimination of the need for sectionalized charts.
- Indication at the process on a big 11¾" scale, visible up to 35 ft. away.

This ingeniously designed transmitter may be Calibrated Linear with Differential Pressure or Calibrated Linear with Flow, and can be either indicating or non-indicating. For computer control, for example, linearized flow is a logical short cut.

Use of a liquid-filled primary gives positive overrange protection. Working parts in the primary are exposed only to the filling liquid—not to the process. Static pressure compensation is inherent in the unique thrust pivot of the force beam. Connections are extremely convenient. Mounting facilities are more adaptable than ever before.

With all its outstanding features you pay no premium for the 212T Transmitter. Ask your Taylor Field Engineer for a demonstration, or write for **Bulletin 98413.** Taylor Instrument Companies, Rochester, N. Y., and Toronto, Ontario.

**Even without this unique feature, the 212T would still be a superior DP transmitter.*

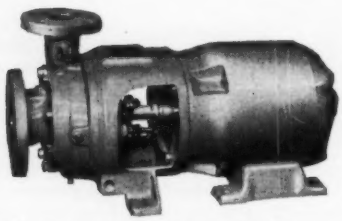
Convenient through-bolted flanges for easy servicing. Process connections top, bottom or side.

213T non-indicating model shows rear mounting and bottom process connections.

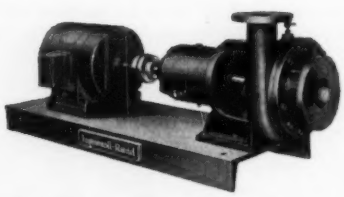
MEAN ACCURACY FIRST

For more data on advertised products, use cards, last page.

when you discuss pumps what does GPM mean to you?



Close-coupled Motorpumps from ¼ through 75 horsepower. 1, 2 and 4-stage models available as well as self-priming types.



Cradle-mounted pumps from ½ through 100 horsepower. Single and two-stage models available as well as self-priming types.

Horizontally-split pumps from 1½ through 400 horsepower. Single and two-stage models available.

THE TECHNICAL DEFINITION

GPM stands for GALLONS PER MINUTE and is the term used in all calculations having to do with the measurement of the flow of liquids.

BUT THERE'S ANOTHER MEANING TOO

Our other meaning of GPM is GOOD PRODUCTION METHODS. This is the reason why our pumps are able to give you the performance that our designers forecast...greater capacity delivered per kilowatt of power input as well as dependable and longer trouble-free pump life.

When you're in the market for a centrifugal pump we are sure you want the best available...The best design, the best efficiency and the best built...one from Ingersoll-Rand. Our commercial pump line is complete with units ranging to 4000 gallons per minute capacity and heads to 1100 feet. Our trained pump specialists are always ready to help you. Call the nearest Ingersoll-Rand branch office or see our authorized pump distributor. There's no pumping problem too tough to handle.

Ingersoll-Rand

250A9 11 Broadway, New York 4, N.Y.

OTHER PUMPS TO 200,000 GPM—PRESSURES TO 6500 PSIG.

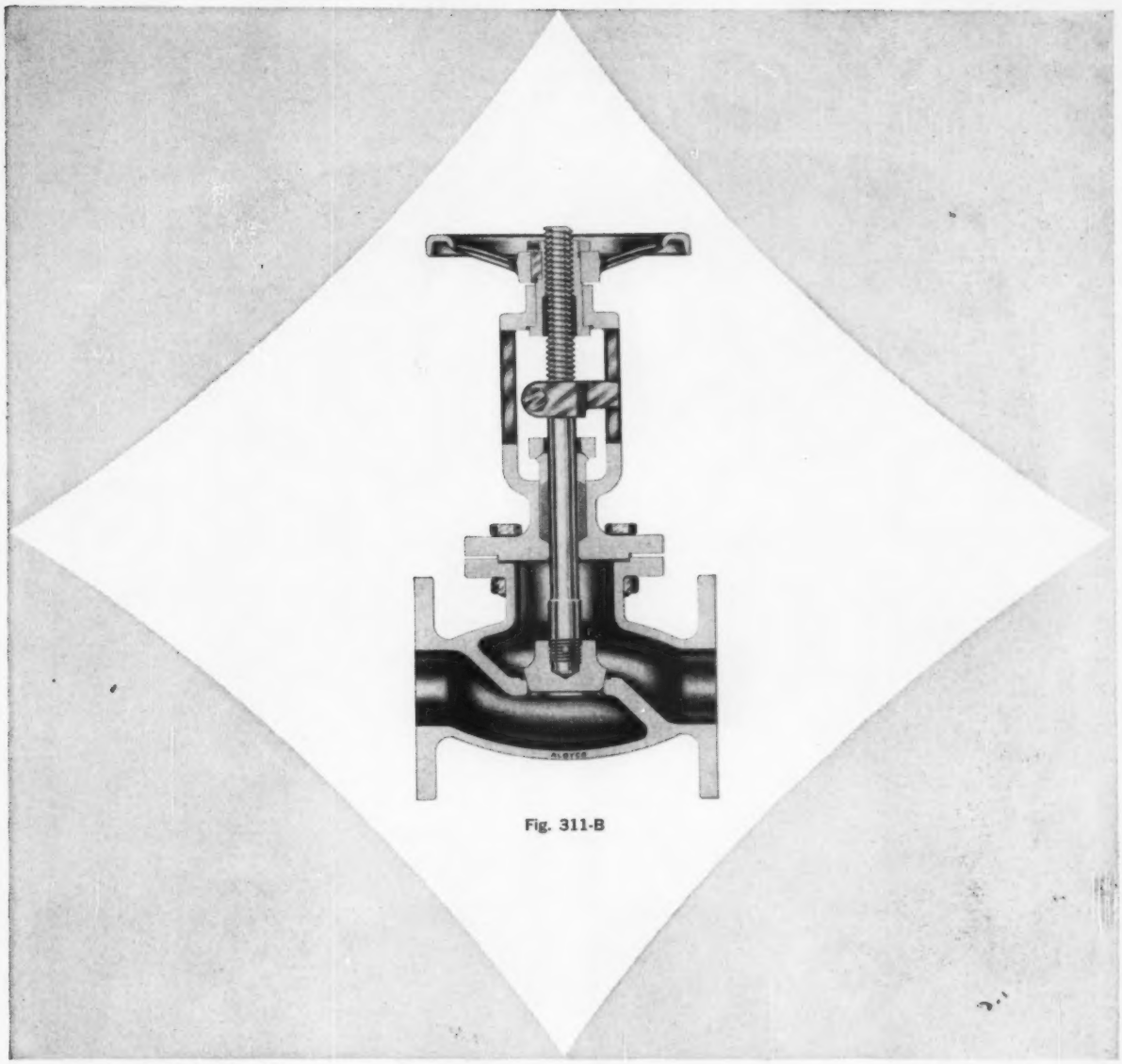


Fig. 311-B

Do you know the advantages of the new Aloyco Globe Valve design?

The design of 150 lb. globe valves of sizes 2" and larger features a non-rotating stem, non-rising handwheel with disc assembly pinned to the stem. This is accomplished by rotating the handwheel and yoke bushing assembly and preventing stem rotating by adding a stem key which fits into the bonnet yoke. The major advantages of the new design result in:

- No spiral wear pattern on stem from hardened packing or hard deposit in stuffing box.
- Rapid visual check of throttling control by observing location of stem stop.
- No galling of back seat because of rotating stem.
- No galling between seat and disc.
- Stronger disc to stem connection.
- No spinning of disc.
- Less corrosion attack because of elimination of cavity between stem and disc.

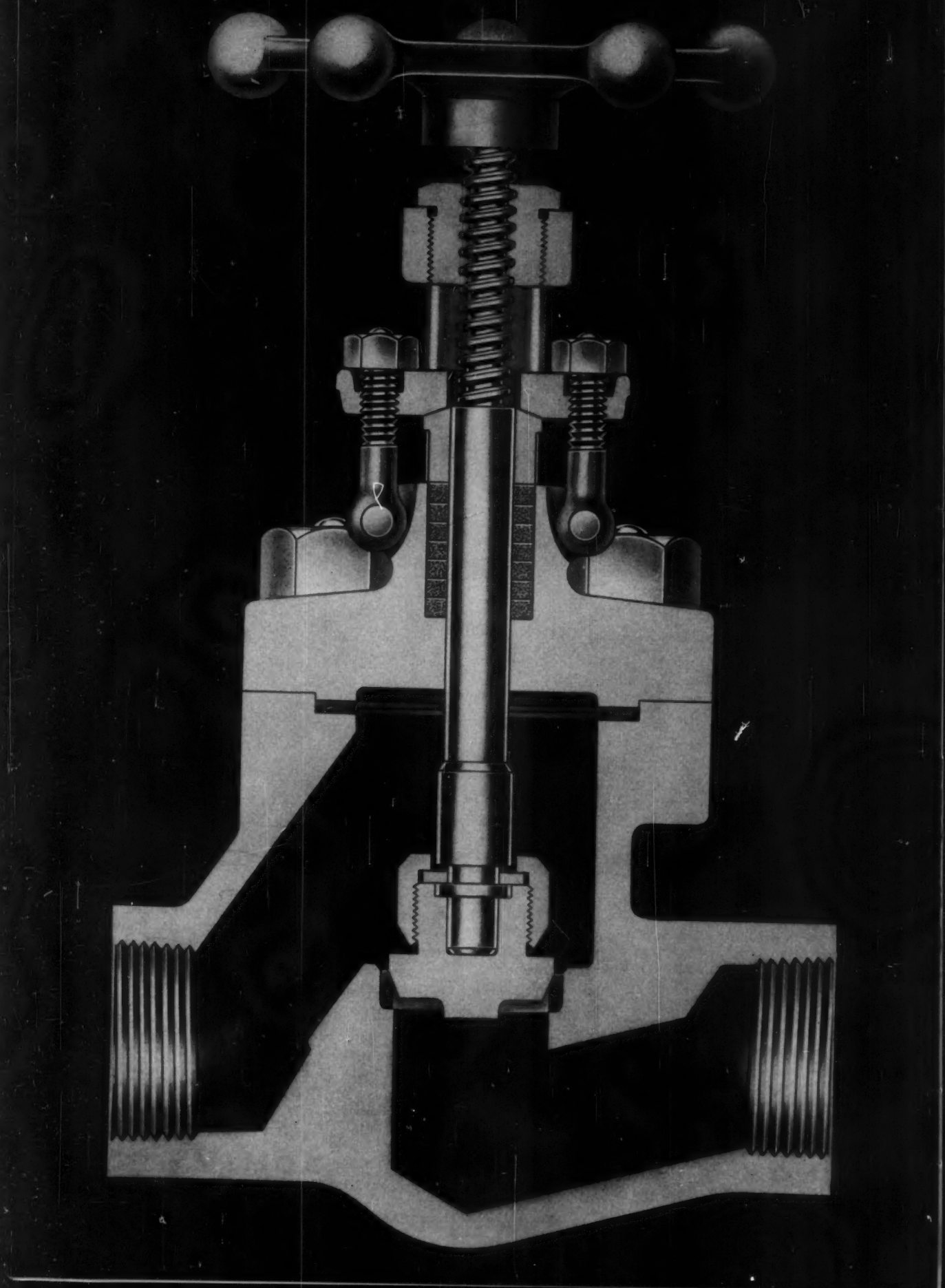
These new design advantages are available in stainless steel and corrosion resistant alloys in sizes 2" and up. For full information write for Bulletin #7, Alloy Steel Products Company, Inc., 1303 West Elizabeth Avenue, Linden, New Jersey. O.11

Subsidiary of

ALLOY STEEL PRODUCTS COMPANY

Boston • New York • Wilmington • Atlanta • Birmingham • Baton Rouge • Buffalo • Pittsburgh • Chicago • St. Louis • San Francisco • Los Angeles • Seattle

For more data on advertised products, use cards, last page.



You can tell a quality valve by the attention it doesn't need

A $25.00 valve seldom seems important yet frequently is responsible for the protection of $100,000 of equipment and material . . .

Hancock Steel Valves are especially engineered and produced to operate dependably under unusual conditions of pressure, temperature, and fluid flow. A wide variety in alternate trim, body, and bonnet materials provides for attention-free, economical service in many different industrial and defense applications where downtime can be costly. Hancock Steel Valves have that extra measure of quality that only a leader can incorporate . . . the extra quality needed to protect processes, power generating nuclear systems, and missile launching equipment.

The valve illustrated at the left is the Hancock Type 5500 Steel Globe Valve widely used for all types of industrial plant services.

For technical assistance in selecting quality Hancock Steel Valves, phone your industrial supply distributor or write for Catalog 200A.

MANNING MAXWELL & MOORE M&M TRADE MARK

HANCOCK Steel Valves

A product of

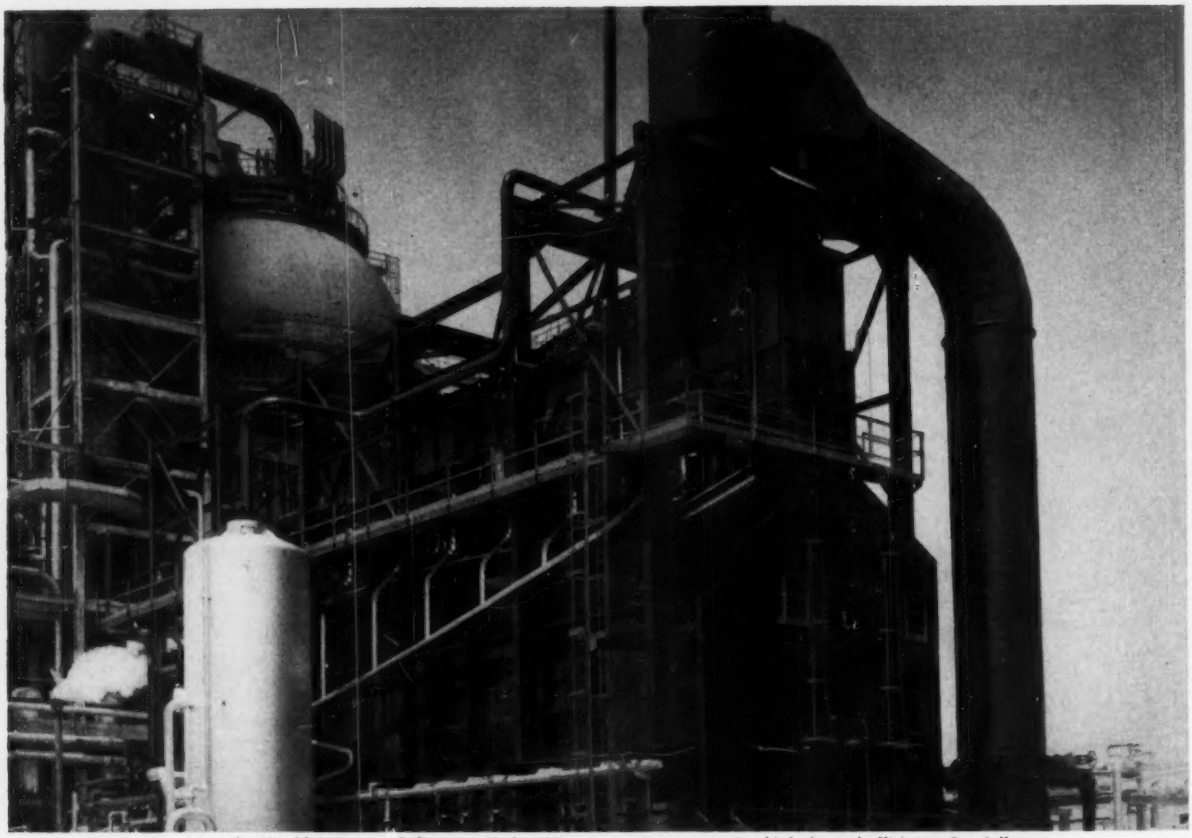
MANNING, MAXWELL & MOORE, INC.

Valve Division, Watertown, Massachusetts

Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario
Latin America: Export Division, Chrysler Building, New York, N. Y.
Europe: Manning, Maxwell & Moore, S.A., Fribourg, Switzerland

LUMMUS

ENGINEERS AND CONSTRUCTORS FOR INDUSTRY



Heater for Humble's Bayway Refinery at Linden, New Jersey. Large capacity, high thermal efficiency. Specially designed integrated heater, air preheater, auxiliaries and stack in compact design to occupy minimum plot space.

Lummus Oil Heater for Humble's Bayway Refinery meets three tough design requirements

LARGE CAPACITY, HIGH EFFICIENCY, LONG RUNS

Humble Bayway knew exactly what they wanted in a replacement heater and turned confidently to Lummus to meet their difficult design requirements.

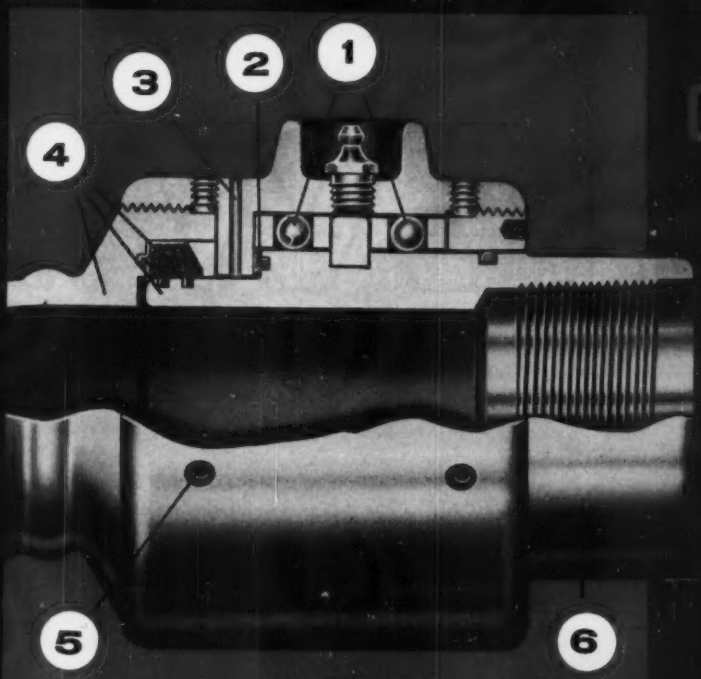
First, the heater had to be large enough to service this giant Cat-Cracker; now one of the largest in operation.

Secondly, Humble wanted a high thermal efficiency, 86% as compared with the usual 75-80%. In the Lummus design, the heater utilizes Ljungstrom Air Preheater and integrated blower and duct system to attain high thermal efficiency. Operating performance has been consistently high. Humble's big fuel savings have more than made up for the slightly higher capital investment for air preheat equipment.

Finally, there was one other difficult design condition. The new heater would be required to operate for long periods without shutting down for maintenance or cleaning. The Lummus design included steam soot blowers which have kept both the bare tubes and studded tube in the convection section clean. The heater fires on heavy residual fuel oil having a very high solids content.

Lummus designs horizontal and vertical tube oil heaters to any size from 100,000 to 300,000,000 BTU/Hour for any process, anywhere in the world. Because Lummus offers *every* type of oil heater, you can be sure that we will recommend the *right* unit for your needs. Consult with Lummus on your next oil heater—large or small.

THE LUMMUS COMPANY, Oil Heater Division, 385 Madison Avenue, New York 17, New York, Houston, Washington, D. C., Montreal, London, Paris, The Hague, Madrid; Newark, N. J.



1. Wide Bearing Spacing . . No Split Races
2. Secondary Seal
3. "Weep Hole"
4. Only Wettable Parts and Packing Contact Fluid
5. Simple Set Screws Allow Joint to Break Like a Union . . Bearings and Other Parts Not Disturbed
6. Thread, Weld, Flanged End Connections Available

CONTINENTAL-EMSCO

US TYPE SWIVEL JOINTS

..handle corrosive chemicals

..stop grease contamination of fluids

..are repaired on location with simple tools

..can be welded into the line

Continental-Emsco US Type swivel joints are designed *exclusively* for the Refining, Petrochemical, and Chemical industries. Fluid contacts metal and packing only, so wettable parts of corrosion resisting stainless steel (or other alloys) can handle all types of caustic products. Primary Teflon packing, *deformed* into grooves for a tight seal, and a secondary asbestos seal prevent grease from contaminating products. Packing chamber design is patented. It reduces bearing wear by preventing packing from pressing against bearings, and allows free swiveling regardless of internal pressure. Joints break like a union without unseating ball bearings and other parts. Joint can be welded into line, eliminating costly flanges. Threaded and flanged ends are also available. Wide bearing spacing through use of solid bearing races insures accurate alignment and provides maximum bearing support for internal and external loadings. Races are separate and can be reversed to double their life. Repairs and adjustments are made on the spot, without special tools . . shop or factory equipment not required.

Save installation and maintenance costs by designing, building or replacing with Continental-Emsco swivel joints. There's a size and type to meet all your product handling problems. Let us bid on your next requirement.

New Swivel Joint Catalog Now Available . . Write for it Today.

CONTINENTAL-EMSCO
Industrial Products Division
P. O. Box 359, DALLAS 21, TEXAS

A Division of The Youngstown Sheet and Tube Company

CONTINENTAL-EMSCO COMPANY • P. O. Box 359-3R • Dallas 21, Texas

Gentlemen: Please send me your current Swivel Joint Catalog. We are planning:
( ) New installation ( ) Replacement ( ) Catalog File

NAME _____ TITLE _____

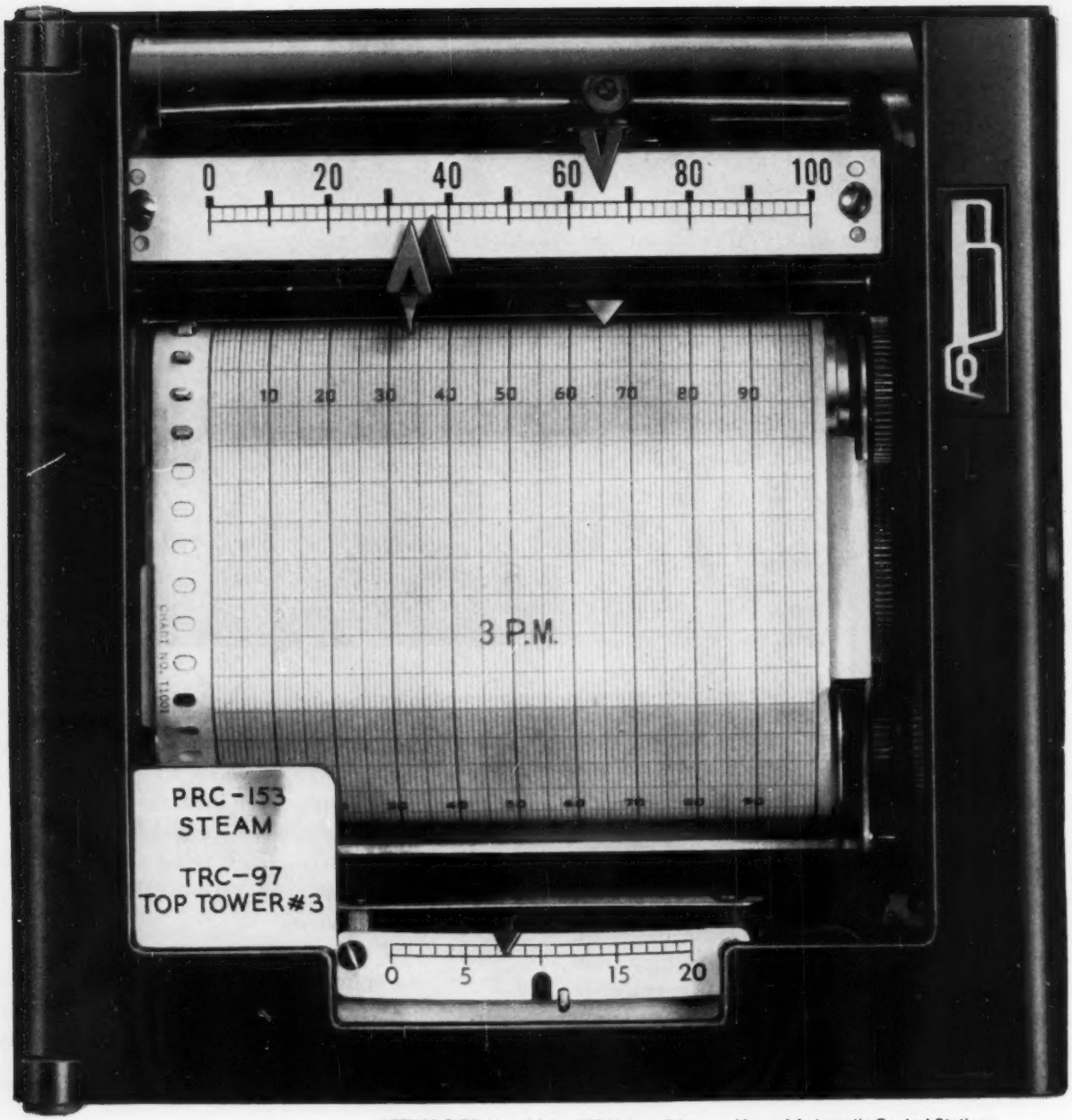
COMPANY _____

CITY _____ ZONE _____ STATE _____

PLEASE PRINT

SJ902

NEW..



ACTUAL SIZE. New Series 670 Metagraphic is ideal for graphic panel applications, occupying panel space only 7" wide by 7⅛" high. Fits into 6" by 6" panel cutout. Typical 670 Series models available, include:

- 1-Pen, 2-Pen, or 3-Pen Receiver
- Manual-Automatic Control Station
- Manual-Cascade Control Station
- Manual-Automatic-Cascade Control Station
- Single-Case Cascade Control Station

here's the pneumatic receiver you asked for!

Bristol's new 4-inch-chart Metagraphic receiver

is the easiest yet to install, operate, and service

Never before has a 3-15 psi pneumatic receiver been designed with such exacting, meticulous attention to the needs of the graphic panel designer, the instrument user, and the instrument maintenance man.

Bristol's new Series 670 Metagraphic receiver brings you the plug-in versatility and operating convenience—made famous in previous Metagraphic pneumatic receivers—plus the increased legibility and accuracy of a 4-inch strip chart, plus these big new features:

Simplified control switching between functions... allows the easiest start-up procedure for either the common manual-automatic station or the more complex, single-case cascade control station models. Intermediate "seal" position has been eliminated. Just adjust process to line-up color-coded indicators and switch to automatic or cascade operation as desired.

Uniform control switching . . . all receiver models have the same switch positions for the various types of control —cascade position, 3 o'clock; manual position, 6 o'clock and automatic position at 9 o'clock.

Simplified chart change and inking . . . chart changing is a one-hand operation. A new chart can be slipped into place in an instant. The capillary inking system can be refilled from the front of the receiver.

And the new Metagraphic receiver gives you other outstanding features such as rectilinear chart coordinates for easiest reading, easy connections for any type of control, either field or receiver-mounted controllers; and sparkless, mercury-switch disconnect of electrical circuit when chassis is removed.

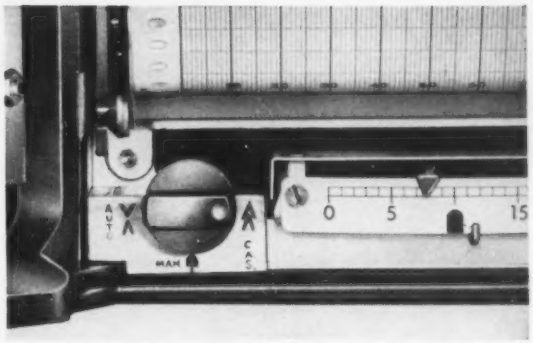
Get the complete story on the new Bristol Metagraphic receiver today. Write The Bristol Company, 111 Bristol Road, Waterbury 20, Conn., a Subsidiary of American Chain & Cable Company, Inc. 0.42

ACCO

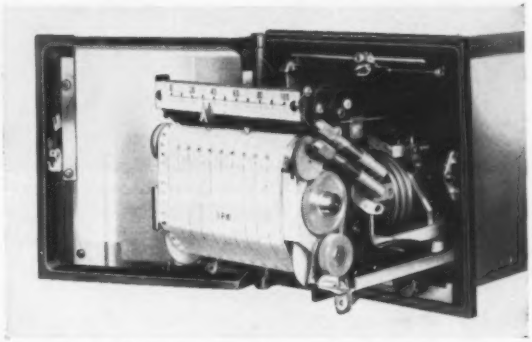
BRISTOL

...for improved production through measurement and control

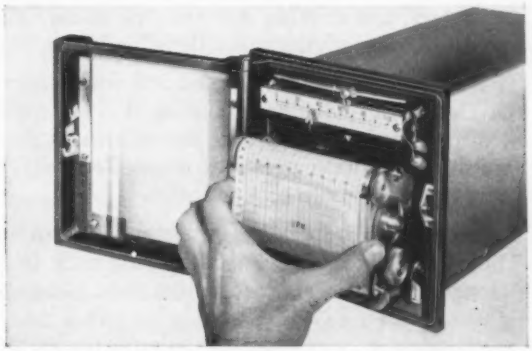
AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS



Simplified control switching is keynote of new receiver's design. For instance: uniform switch positions on all models avoid operator confusion in multi-receiver installations; simple alignment of color-coded pointers and a single switching operation put complex automatic or cascaded systems "on stream."



Complete "plug-in" service continuity. Entire plug-in receiver chassis is instantly replaceable with spare for complete continuity of service. Control functions are not disturbed when receiver chassis is removed.



Easiest to service . . . For instance: Easily removable chart drive mechanism—a one-handed operation—permits exceptionally fast chart replacement; just slip out drive, replace with spare, replace paper in original drive at leisure.

THERE'S NO "OR EQUAL" TO DEARBORN'S ENDCOR® FOR COOLING WATER TREATMENT

1. No treatment. 2. Chromate-polyphosphate mixture—50ppm. 3. Chromate-polyphosphate mixture plus Endcor A—50ppm.
Unretouched photographs showing the effect of Endcor A in cooling water treatment at a pH of 6.5 and a temperature of 130° F.

Today, there's more than two years of performance proof behind Dearborn's cooling water treatments with the research developed additive, Endcor.

And today, more and more companies, with millions of dollars worth of cooling systems and equipment to protect, are striking out the "or equal" clause and directly specifying one of these Endcor products.

There's Polychrome ® 501 and 505 with Endcor A . . . Dearborn ® 860 with Endcor B . . . and others —all designed to do specific corrosion and deposit inhibiting jobs more precisely, more effectively, and, in many cases, more economically.

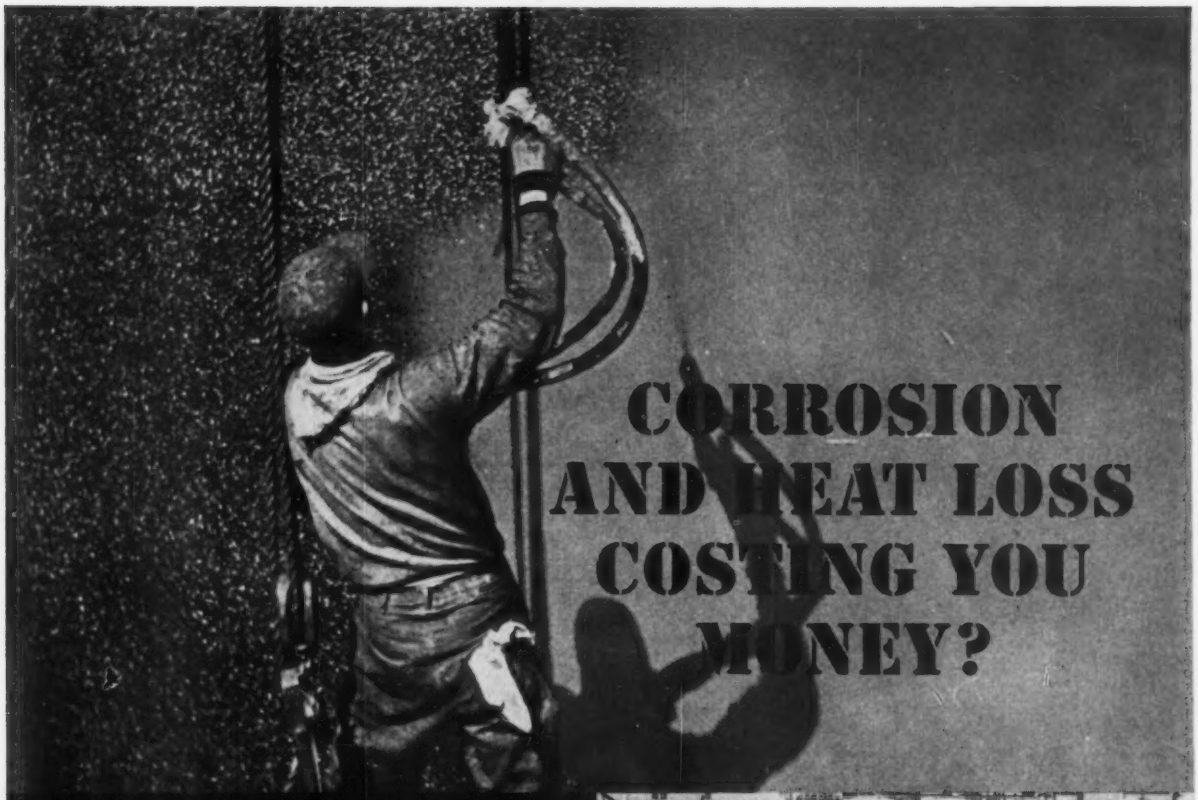
Behind these products are important "pluses," too. There's Dearborn's experience dating back to 1887 —longest in the water treatment field. There's its extensive research facilities . . . its modern, completely equipped laboratories to provide truly scientific answers to specific and baffling problems . . . its Technical Center in Chicago staffed with recognized experts to back up products and Dearborn engineers in the field.

Because of its critical importance to overall results, Dearborn also provides the most complete and effective line of chemical feeding equipment of any water treatment company.

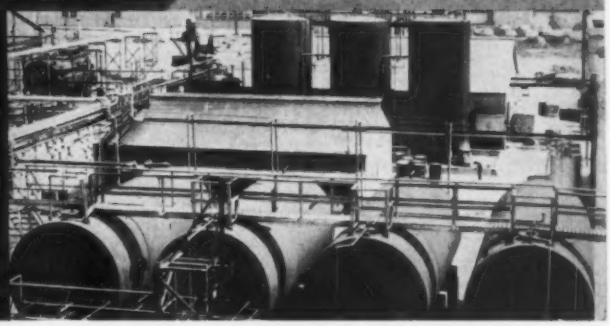
We'll be glad to send you Technical Bulletins on our Endcor products. Or to consult with you on any water treatment problem, without cost or obligation. Call or write us today.

DEARBORN CHEMICAL COMPANY

General Offices: Merchandise Mart, Chicago 54 • Dallas • Des Plaines, Ill. • Ft. Wayne • Honolulu
Linden, N.J. • Los Angeles • Nashville • Omaha • Pittsburgh • Toronto • Havana • Buenos Aires



PROTECT AND INSULATE IN ONE APPLICATION



You can effectively protect and insulate storage tanks, buildings and other structures, whether metal, cement, brick or other materials, against corrosion, abrasion, weathering and the harmful effects of sunlight. Here are two economical products that will be of interest to you.

Pioneer Cork Insulation, for example, is a cold applied, bituminous-base composition containing cork and asbestos fillers for lasting efficient protection and insulation of heated outdoor storage tanks. Fuel savings alone usually recover cost of application in one winter's time. **Pioneer Vapor Seal** is a carefully selected blend of asphalts and other resistant materials that provide long-lived protection for all types of structures with easy, economical application. Colored slate or ceramic granules may be added to enhance surface beauty.

Interested in further information? Just fill in and send coupon.

PIONEER PRODUCTS DIVISION
WITCO CHEMICAL COMPANY, INC.
122 East 42nd Street • New York 17, N. Y. Dept. 82-02,

I would like information on protective and insulating coatings for the application listed below: Please send ☐ Samples ☐ Representative

Application_____

_____

Name_____

Company_____

Address_____

City_____ Zone_____ State_____

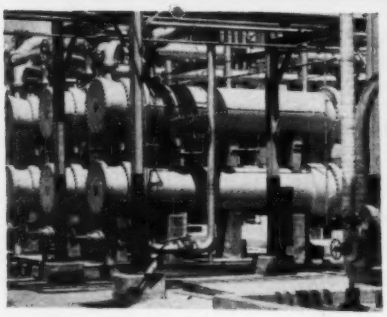
TO PROTECT OR INSULATE ANY STRUCTURE . . . ANY SURFACE, WITCO MANUFACTURES A COMPLETE LINE OF PIONEER ASPHALT AND ASPHALTIC SPECIALTY PRODUCTS

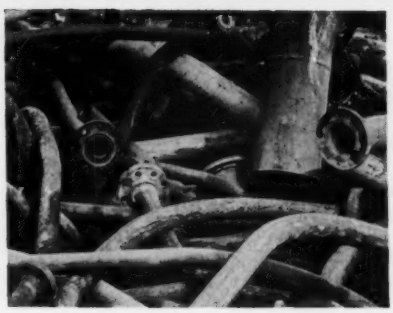
SEE OUR CATALOG IN SWEET'S

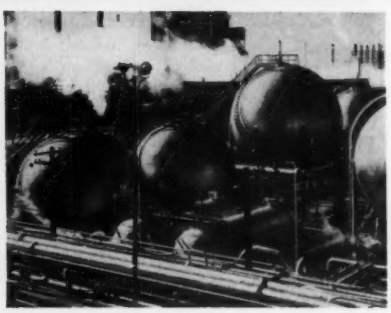
WITCO CHEMICAL COMPANY, INC.
PIONEER PRODUCTS DIVISION
Dept. 82-02, 122 East 42nd Street, New York 17, N.Y.
Sales Offices: New York • Chicago • Los Angeles • Toronto and Montreal, Canada

For more data on advertised products, use cards, last page.

Here's what you can expect







RESULTS LIKE THESE:

Typical case histories tell the story of Oakite ECP's at work in various refineries. They helped:

- **cut 3½ days, $2,250 from previous absorber turnaround time; knocked 5 days, $3,300 from reformer tower turnaround; put fouled catalytic reformer furnace back on-stream in 2 days.**
- **reduced tube bundle cleaning costs 70%; saved 8-year-old tube bundles from scrap heap.**
- **cut parts salvage operation from 22 hours to 1½ hours per batch.**
- **stripped paint from tank exterior in just a few hours; cleaned asphalt storage tank interior in 1½ days.**

Ask the Oakite man to give you complete information, or send for these valuable bulletins. Write Oakite Products, Inc., 48 Rector Street, New York 6, N. Y.

from an Oakite ECP

engineered cleaning program

Savings in turnaround time, in money, man-hours, and maintenance—these are some of the things you can expect from an Oakite Engineered Cleaning Program. ECP takes a scientific approach to cleaning *through chemistry*. It is tailored specifically to suit your refinery, your equipment, your soils, your throughput. ECP gives you:

DETAILED RECOMMENDATIONS

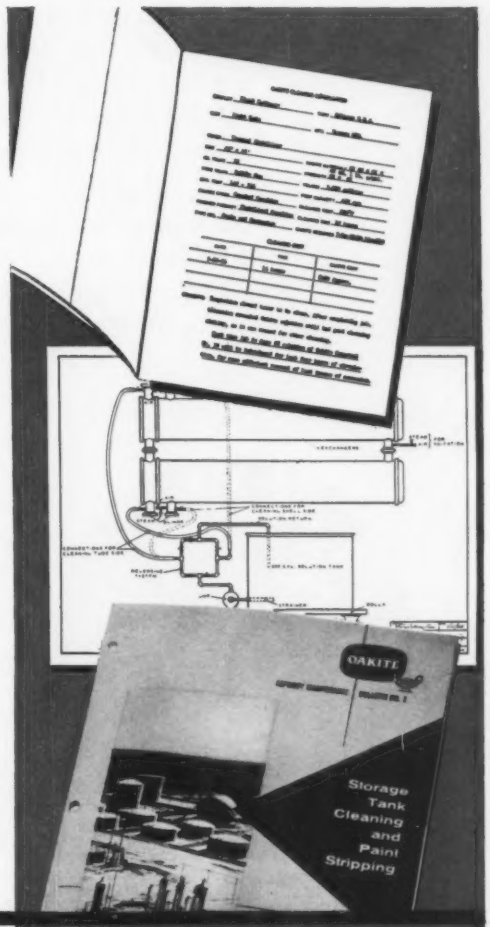
Specific cleaning recommendations—tower by tower, bundle by bundle—are outlined in a complete, written report. It includes estimated quantities of materials required, estimated off-stream time, step-by-step instructions for your crew. ECP utilizes time-saving mechanized and in-place cleaning wherever possible.

TECHNICALLY QUALIFIED AID

To implement the program, the Oakite man sticks with the job until your crew is fully oriented. He brings with him a background of practical refinery cleaning experience... coupled with materials and methods from the finest cleaning research laboratory in the country. In short, your Oakite man is expressly prepared to give you top efficiency, speed of operation *plus* low-cost end results.

ENGINEERING DRAWINGS, LITERATURE

Engineering drawings of suggested equipment and pumping hook-ups are included in the ECP. And fact-filled literature that details cleaning procedures is made available.



OAKITE

over 50 years' leadership in industrial cleaning

Est. 1909 SCIENCE

ECP

your economy key

For more data on advertised products, use cards, last page.

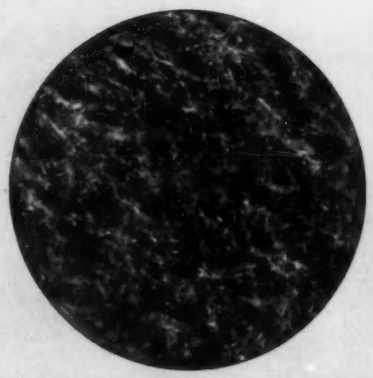
IT'S THE INTERLOCK THAT MAKES MONO-BLOCK®

It's no wonder that hundreds of industries' leaders specify Baldwin-Ehret-Hill Mono-Block for their medium and high temperature block insulation requirements, up to 1800 F.

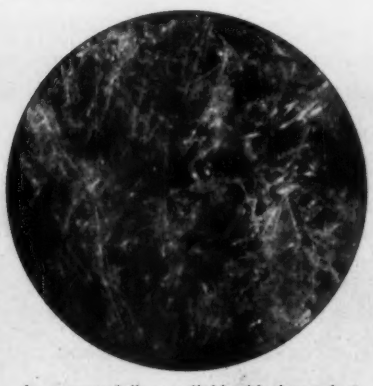
The reason? An exclusive Baldwin-Ehret-Hill manufacturing process assures that the fine mineral wool fibers used in Mono-Block are completely and thoroughly dispersed in a liquid slurry and thereby interlocked to provide the highest strength. Further, this interlocking process means that Mono-Block will cut cleanly and conform to irregular surfaces, such as lap or butt welds, etc., without tearing or breaking.

Another reason for Mono-Block's leadership is its high strength, minimizing loss due to breakage. And the tough, strong surface of Mono-Block can be directly finished with Baldwin-Ehret-Hill No. 1 or Super Powerhouse Cements in many instances without the need for applying wire mesh.

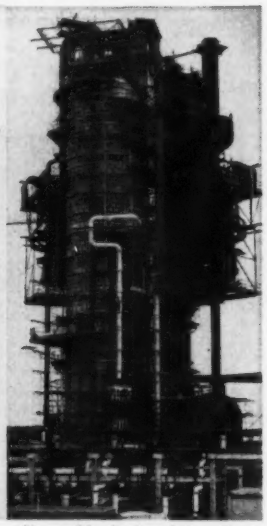
For detailed information about Mono-Block or any of the complete line of industrial insulations manufactured by Baldwin-Ehret-Hill, and the name of your nearby B-E-H qualified contractor, write to Department M-B, Baldwin-Ehret-Hill, Inc., 500 Breunig Ave., Trenton 2, N. J.



B-E-H Mono-Block magnified 10 times to show uniform, interlaced structure resulting from interlocked fibers.



A commercially available block product equally magnified to show the uneven texture.



Mono-Block insulates the world's largest catalytic cracking unit for Tidewater in Delaware.

B E H
BALDWIN-EHRET-HILL

Baldwin-Ehret-Hill manufactures a complete line of mineral fiber, calcium silicate, 85% magnesia and polyurethane industrial insulation products, including pipe insulation, blocks, blankets, felts, cements and loose fill for sub-zero to 1900 F service.

BALDWIN-EHRET-HILL, INC.

Trenton **New Jersey**

For more data on advertised products, use cards, last page.

Quality can not be Imitated

For more than 35 years Koch Engineering Company has served industry. Adherence to the highest mark of quality has resulted in the build-up of a top-flight engineering staff. Their skills — combined with the latest facilities for design, development, and testing — originated today's most economical fractionating tray: *the Koch Flexitray*. Their experience — gained through years of leadership in research and practice — is your assurance of the *continued* quality of this low-cost . . . widely imitated tray.

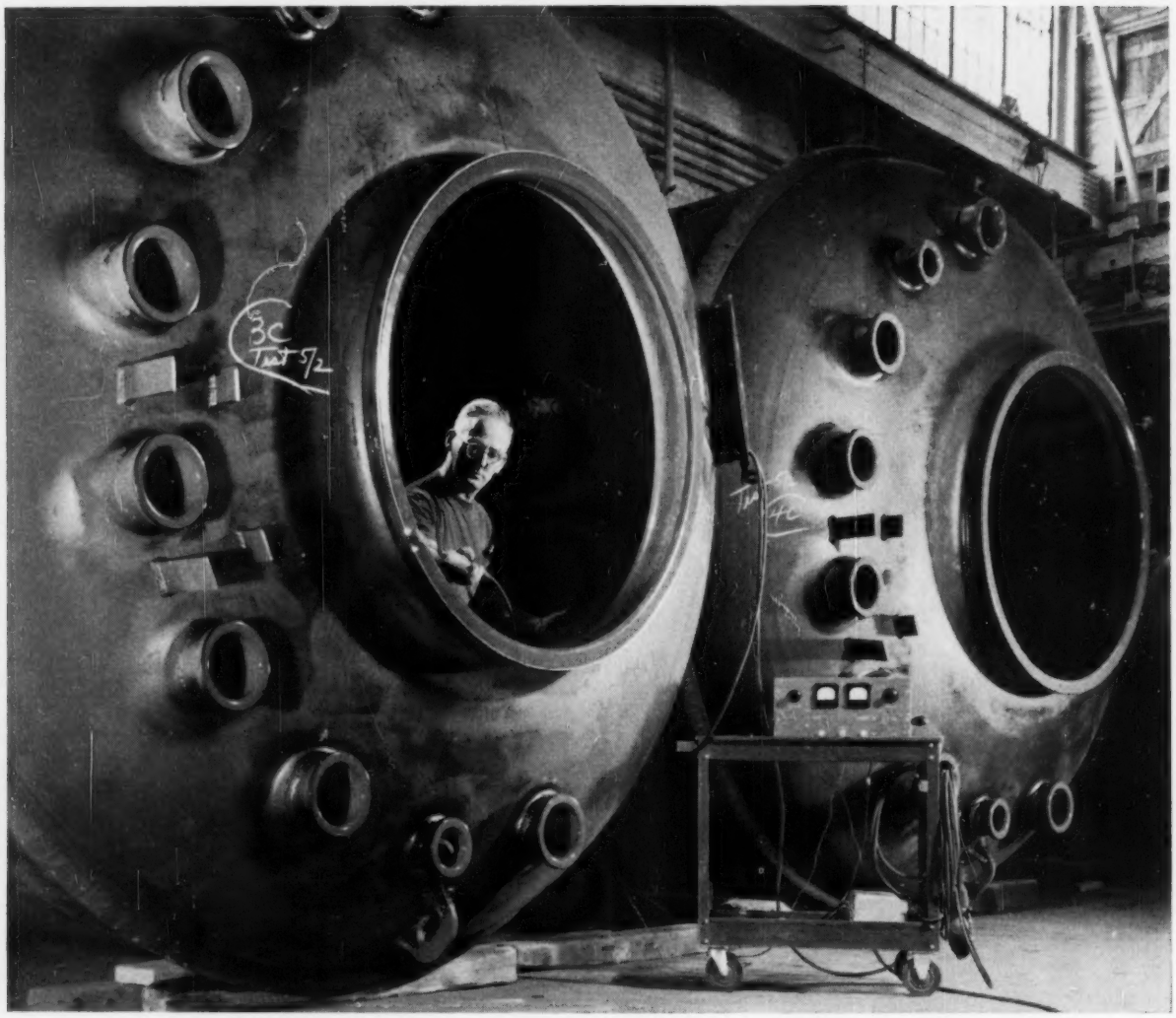
In specifying fractionating devices for your next tower installation — remember: the *quality* of Koch Flexitray can *not* be imitated!

See our catalog in "Refinery Catalog" — or contact your nearest Koch Representative.

Butte, Montana — G. M. Wallac & Co., P. O. Box 208
Charleston 1, W. Va. — D. D. Foster Co., 1108 Nelson Bldg.
Denver, Colorado — G. M. Wallace & Co., 324 Denham Bldg.
El Paso, Texas — G. M. Wallace & Co., Suite 511, Electric Bldg.
Houston, Texas — Alpha Engineering Co., P. O. Box 12371
Kansas City 13, Mo. — Sample Brothers, P. O. Box 7061
New York 17, N. Y. — F. J. McConnell Co., 60 East 42nd St.
Oakland, California — Engineered Process Equip. Co., 600 16th St.
Park Ridge, Illinois — M. B. Fisher, 1521 Courtland Ave.
Pasadena, California — Engineered Process Equip. Co., 774 E. Green St.
Pittsburgh 19, Pa. — D. D. Foster Co., 2210 Koppers Bldg.
Salt Lake City, Utah — G. M. Wallace & Co., Continental Bank Bldg.
St. Louis 17, Missouri — Sample Brothers, 2010 Big Bend Blvd.
Tulsa 16, Oklahoma — Myers-Aubrey Co., P. O. Box 5436
Scarborough, Ontario, Canada — Muirhead Fromson Ltd., 65 Hymus Road
Fribourg, Switzerland — Koch Flexitrays, S. A., 20 rue St. Pierre

European Fabrication Available!

FLUIDICS* AT WORK



With Glasteel reactors you get a full-year guarantee against corrosion

This man is electric testing the interior of a Pfaudler® Glasteel reactor. He's making sure that every inch of the inside product-contact surface is completely covered with corrosion-resistant glass.

That's the *glass* in Glasteel. Outside there's *steel* for working strength. Fusing the two together gives you a combination that lets you forget—rather than fight—corrosion.

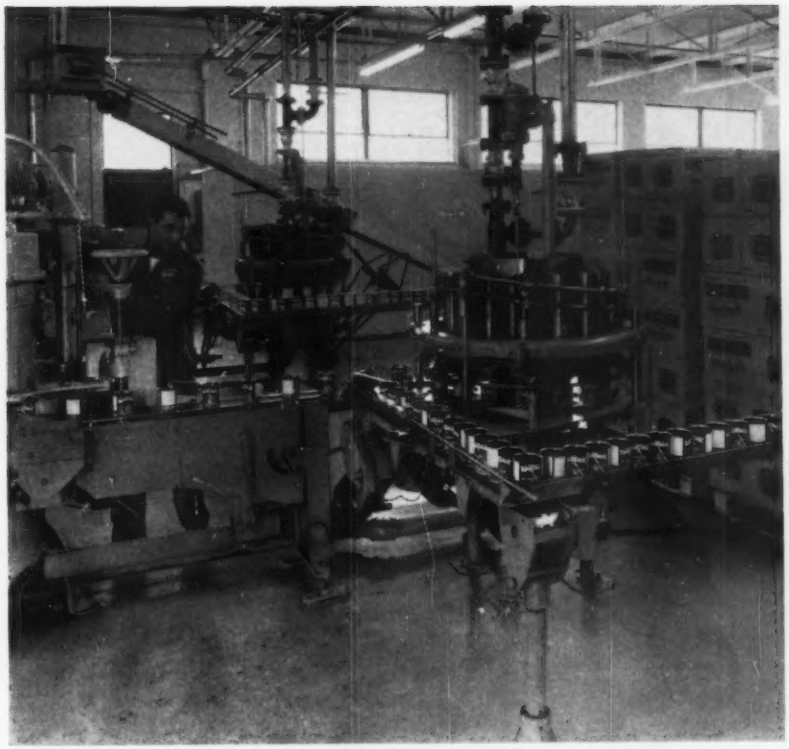
Guaranteed resistant. Glasteel has a natural resistance to corrosive attack. You can use it safely with all solutions of all acids except HF to 212° F (even up to 450° F for certain acid solutions, depending on concentration) and with many alkalies at moderate temperatures. You can do so with complete confidence, since Pfaudler Glasteel equipment is guaranteed against corrosion for a full year after shipment, when used under operating conditions specified and approved. If rendered unusable by chemical attack during this period, Pfaudler will repair or replace it, f.o.b. factory.

Protection plus. That's only part of the story. Glasteel also is inert; it won't influence quality, flavor, color or purity of your products. And its smooth, abrasion-resistant surface resists product buildup. Heat transfer is not impeded by surface fouling by product or corrosion, and cleaning is both quick and complete with a minimum of effort.

Wide choice. You can put these advantages of Glasteel to work in many ways. Select from one-piece, all-welded reactors in standard sizes from 300 to 4,000 gallons—custom designs to 10,000 and even larger. You can also get polymerizers, columns, storage tanks, pumps, pipe, valves and fittings in a range of sizes.

Sound investment. You'll find that Glasteel is actually lower in cost than many of the specialty alloys your processes may require. And Glasteel is your soundest investment when long service life is considered.

More facts. Bulletin 988 spells out the details on Glasteel reactors and Bulletin 932 covers Glasteel polymerizers. For your copies, write to the address shown on the facing page.



Two Pfaudler Rotary Piston Fillers package a variety of viscosities and container sizes at Bardahl Lubricants Inc., Norwood, Mass.

No filler maintenance in two years at Bardahl

No maintenance. No parts replacement. That's the performance record for these Pfaudler RPL-14 Rotary Piston Fillers after *two years* of service.

Bardahl runs this production line with these two fillers handling oils which vary in viscosity from SAE-5W to SAE-50W. Filling rates are as follows: 4-oz. containers at 260 cans per minute, 15-oz. at 225 cans per minute, and quarts at 190 cans per minute.

These are *not* the top operating speeds for the RPL-14, since they are geared to Bardahl's *current* production requirements. Actually, these machines are capable of 350 quarts per minute.

Bardahl tolerates *no* spillage – and none occurs in this installation. One reason why you might consider Pfaudler fillers in your plant. Other reasons?

Simplicity is a key factor. Pfaudler fillers offer a design in which piston and valve can be disassembled without tools in a few minutes.

There are no connecting rods or wrist pins to wear out, no piston rings.

You can quickly clean and visually inspect both filler bowl and valve body. And all gearing is totally enclosed in an oil bath.

Accuracy can be held to ±1/10 of an ounce for most materials. You can adjust fill accuracy from a single control point, *without* stopping the machine.

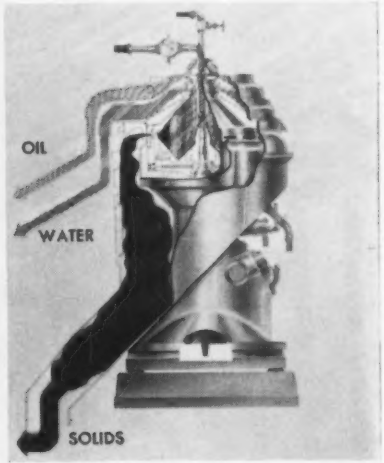
Matched to your needs. The RPL-14 is one of a complete line of fillers from Pfaudler, each designed to meet specific oil-packaging requirements. For example, the RPL-36 can handle as many as 800 quarts per minute.

More information. Bulletins No. 964 and No. 878 give specs on the Pfaudler line of fillers for oil packaging. Write for copies to the address shown on this page.

*FLUIDICS is the Pfaudler Permutit program that integrates knowledge, equipment and experience in solving problems involving fluids.

How to squeeze more profit out of tank-bottom sludge

Here's a centrifuge that can really add measurably to what you recover from tank bottoms.



With a Pfaudler Titan Superjector you get a 3-way split of oil-water-solids simultaneously in a single pass.

With this Titan Superjector you can efficiently separate oil-water-solids simultaneously, *in a single pass*. You have a settling power up to 7500 times gravity, much more force than you get with most continuous centrifuges.

Equally important, sludge discharge is through slots—*not* nozzles. These slots are 3/8 inch by 5 inches and handle drier, more compacted sludges with particles up to 1/8 inch in diameter. There is no down time for cleaning bowl or clogged nozzles. Adjusting the hydraulic controls accommodates varying solids content of the feed and desired sludge dryness.

We'll run tests in our Engineering Test Center or *in your plant* with a portable production unit. More details found in Bulletin 946. Write for your copy.

New Glasteel bulletin

All the pertinent data on Glasteel, the *material of construction*, have now been brought together in a single full-color brochure.

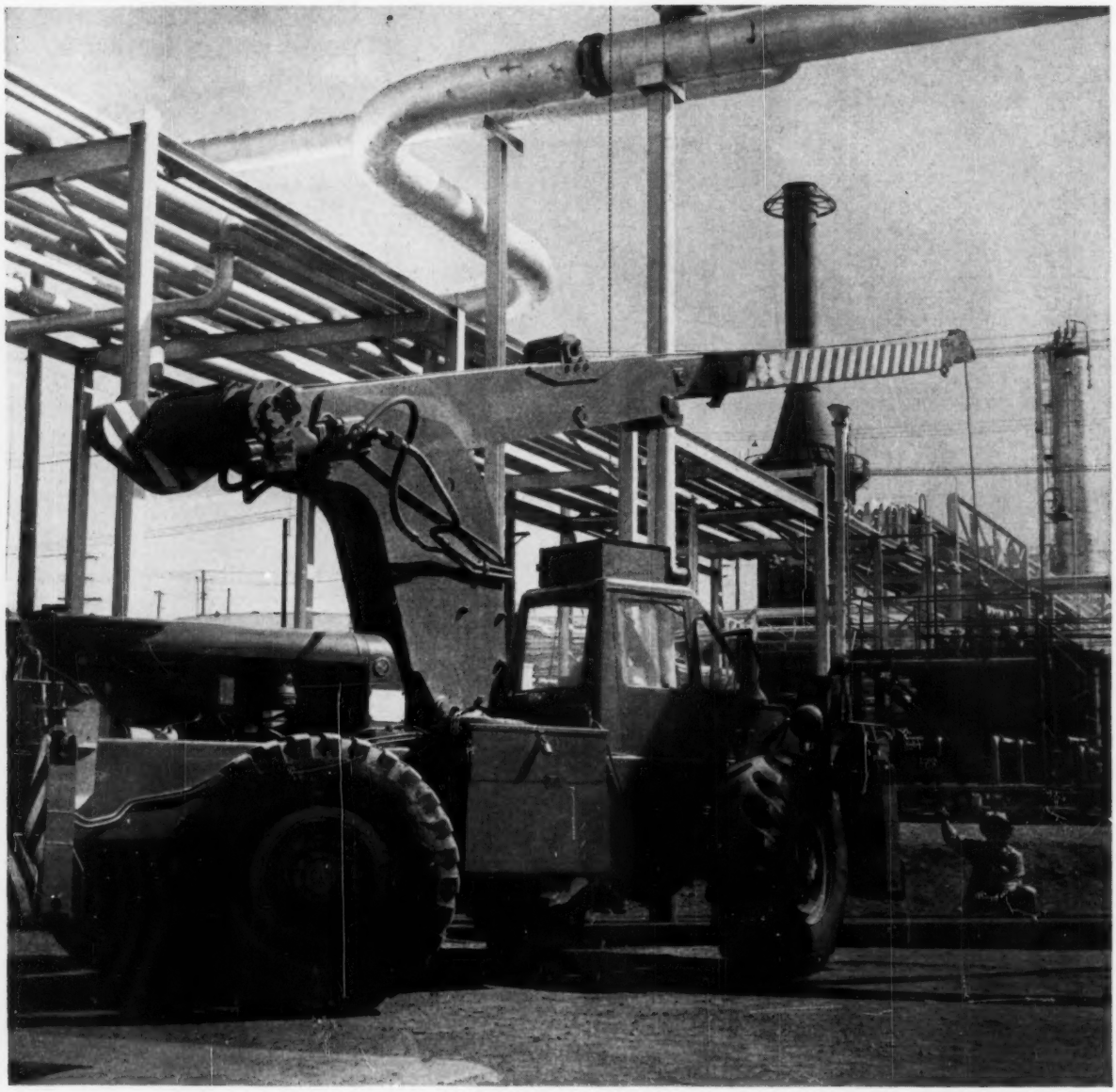
It's Bulletin 985, and in its 20 pages you'll find 16 pages of *technical data* on thermal shock, operating temperatures, specifications, and corrosion resistance. Write for your free copy today.

Please address all inquiries to our Pfaudler Division, Dept. PR-61, Rochester 3, New York.

PFAUDLER PERMUTIT INC.

Specialists in FLUIDICS . . . the science of fluid processes

For more data on advertised products, use cards, last page.



Read how this low clearance 7-ton crane eliminates A-frames and staging erection . . .

It is an Austin-Western hydraulic crane —highly mobile, self-propelled. Available in five models with capacity ranges from 5 to 11 tons. Low clearance (11 ft. 1 in. on biggest model) lets you move in fast for repair and maintenance and without dismantling overhead pipes for crane passage.

Optional personnel platform attachment carries men aloft—no staging to erect. An A-W can thread its telescoping boom into the most impossible places for safe lifts with speed and precision. Boom rotates in continuous full circle; hydraulically retracts and extends to lengths up to 48 feet on some models.

Inefficient A-frames are obsolete. The A-W cranes, equipped with all-wheel drive and steering, are so maneuverable they can operate efficiently in quarters too tight for other lifting units to enter.

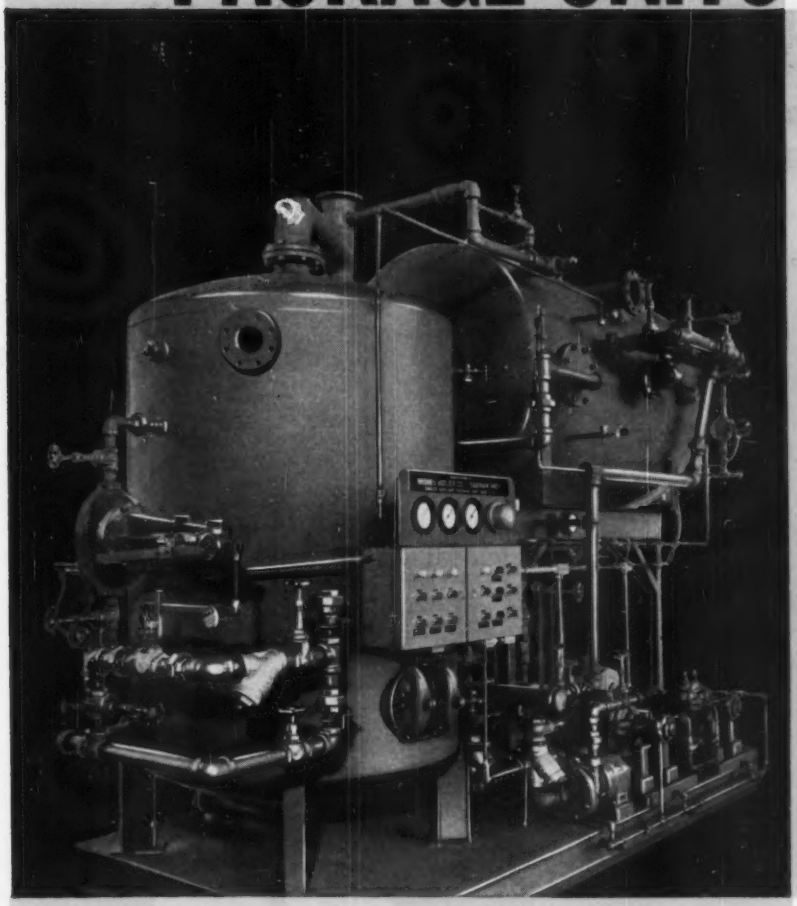
This is top-quality equipment—dependable to operate, inexpensive to maintain. Ask your nearest A-W distributor for more information and the names of refinery owners of A-W cranes —or write us here in Aurora.

Austin-Western CONSTRUCTION EQUIPMENT DIVISION, AURORA, ILL.

BALDWIN · LIMA · HAMILTON

WICKES BOILER AUXILIARY PACKAGE UNITS

standard



Save On First Cost • Engineering • Building Space • Construction Time • Operating and Maintenance Cost

Wickes Boiler Co. now offers a packaged system of various compact combinations of DEAERATING FEED WATER HEATERS, BOILER FEED PUMPS, CONDENSATE SURGE TANKS and BLOW-OFF TANKS. Standard units available for steam plants of 10,000 to 100,000 lbs. of steam per hour capacity and steam pressure to 300 PSIG. Information on special units of higher capacities and pressures upon request. Each unit is shop-assembled on a structural steel base, completely piped and wired and equipped with all necessary controls and an instrument panel.

173

Write today for Bulletin 59-1, which gives detailed engineering information on all three models of Wickes Boiler Auxiliary Package Units.

WICKES BOILER CO., SAGINAW 18, MICHIGAN
Division of The Wickes Corporation

WICKES

RECOGNIZED QUALITY SINCE 1854

SALES OFFICES: Atlanta • Boston • Charlotte, N. C. • Chicago • Cleveland • Dallas • Denver • Detroit • Houston • Indianapolis • Los Angeles • Memphis • Milwaukee • New Orleans • New York City • Philadelphia • Portland, Ore. • Rochester, N. Y. • Saginaw • San Francisco • Seattle, Wash. • Springfield, Ill. • Tulsa

For more data on advertised products, use cards, last page.

Republic ELECTRUNITE Stainless Steel Heat Exchanger Tubes

for longer life under the demanding conditions of the petro-chemical industry

Where adverse conditions impose severe corrosion problems, Republic ELECTRUNITE Stainless Steel Heat Exchanger Tubes contribute to long-lived, trouble-free installations.

In producing ELECTRUNITE Stainless Steel Heat Exchanger Tubes, Republic combines years of experience as the world's largest producer of stainless steel with the superior features of all Republic tubular products.

Exclusive ELECTRUNITE process electrically welds tubing from highest quality flat-rolled steel without extra metal. Result is a concentric tube—no thin or heavy spots—with constant strength through the entire length. Also, uniform wall thickness and ductility make rolling-in strong and sure.

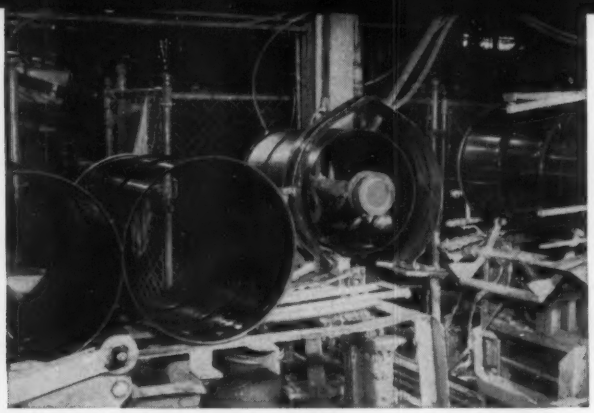
All ELECTRUNITE Heat Exchanger Tubes can be supplied FARROWTESTED at no increase in cost. FARROWTEST, the ultimate in nondestructive production line testing, probes the entire tube wall, rejecting tubes with minute defects too small to be detected by ordinary pressure methods.

In heat exchanger applications, be sure to specify ELECTRUNITE. For complete information call your Republic representative, or mail coupon.

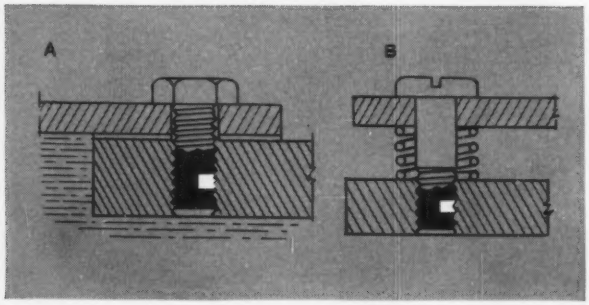
ELECTRUNITE HEAT EXCHANGER TUBES ROLL IN EASILY, provide strong, even seat. Concentricity and uniform ductility guard against weak spots or leaks.

Strong, Modern, Dependable

Steel



ELECTROSTATICALLY LACQUERED DRUMS provide maximum protection for highly corrosive or easily contaminated products. Through Republic's ELECTRO-LAC Process, a high speed distribution head disperses a fine lacquer mist over the entire interior of the drum. Electrostatic field produced in the drum assures uniform coverage, no thin spots. Ask your Republic Container salesman for details or mail the coupon.

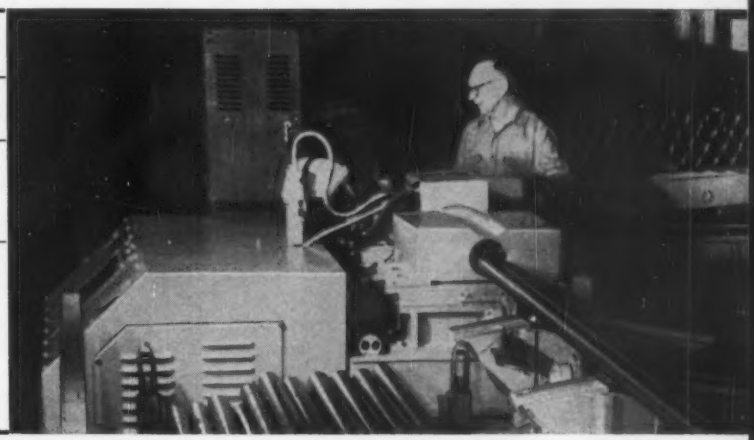


NYLOK—ANSWER TO FASTENER PROBLEMS caused by shock and vibration. A nylon plug firmly staked into one of the faces of a nut or body of a bolt forces a tight, metal-to-metal contact of opposite mating threads for vibration-proof lock. Typical NYLOK applications: (a) NYLOK Bolt used as a fastener-sealer to effectively block fluid escape along thread path; (b) NYLOK Bolt used to solve vibration problems in spring loaded application. Write for more information on NYLOK Bolts and Nuts.

FARROWTEST REJECT TABLE

Wall Thickness (B.W. Gage)	Minor dimension of the defect (Length or Depth)	Defective Area (Length, Depth Plane)
20	.006"	.0025 sq. inches
18	.006"	.003 sq. inches
16	12½% of wall	.003 sq. inches
14 and 13	12½% of wall	.004 sq. inches
12 and heavier	12½% of wall	.005 sq. inches

FARROWTEST detects and rejects not only tubing containing defects which completely penetrate the wall; but also tubing with defects equal to, or greater than, those shown in this table. For irregular defect shapes, a tube with defect area equal to or greater than shown above is rejectable. Where required, sensitivity of FARROWTEST equipment can be calibrated to reject defects of lesser specified area than shown in table, at extra cost.



FARROWTEST—QUALITY YOU CAN MEASURE. Not just laboratory theory, not a mere inspection tool, but an exclusive eddy-current production line test that detects and rejects tubing containing defects of critical size. FARROWTEST is offered as an alternative to other less positive tests, in accordance with the table above, at no extra cost.

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REPUBLIC STEEL

REPUBLIC HAS THE FEEL FOR MODERN STEEL

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☐ FARROWTEST® ☐ NYLOK® Bolts and Nuts
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Photographed at DX Sunray, (Tulsa Refinery)

For higher yield... new Aerocat 3C

CAN YOU USE a higher yield of gasoline—? or of propylenes or butylenes—? Then investigate the new AEROCAT 3C! It's a new fluid cracking catalyst composition, developed by Cyanamid in cooperation with a major oil company. AEROCAT 3C-12 gives increased gasoline yield . . . AEROCAT 3C-20, increased propylene and butylene yields . . . both at the expense of dry gas and coke.

In actual commercial operations, these new three-component catalysts have proved their ability to provide refiners with more flexible, more profitable operation. They are highly active, exceedingly stable, and completely operative.

Your "Man with the Golden Rule"—your Cyanamid salesman—will be glad to work with you to determine the suitability of AEROCAT 3C for your needs. He knows catalysts—and behind him are the resources of a major producer of both catalysts and other chemicals. Why not call him now?

Basic in catalyst chemistry

CYANAMID

AMERICAN CYANAMID COMPANY • REFINERY CHEMICALS DEPARTMENT • 30 Rockefeller Plaza, New York 20, New York

THE QUESTION:

"We are operating at a reflux ratio of 1:1 with a vapor velocity of 4 feet per second. The system is acetone and water. Packed depth is 30' of porcelain raschig rings. How many more transfer units can I get if I switch from 1" raschig rings to Intalox saddles?

This question is typical of those which can be answered by referring to the data appearing in U. S. Stoneware's Engineering Manual on Packed Towers . . . data reflecting the results obtained from our continuing research into the mechanics of packed tower operations, conducted in our experimental towers in our laboratories in Akron.

THE ANSWER:

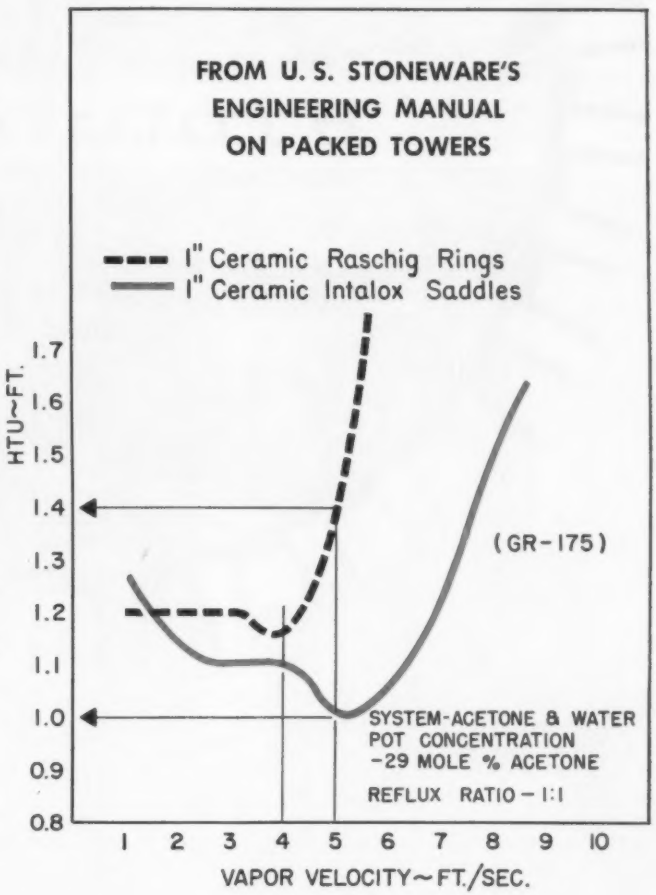
The curves in the chart at the right reflect the performance of 1" ceramic raschig rings and 1" ceramic Intalox® Saddles in a series of test runs in our experimental towers with the system: Acetone and water.

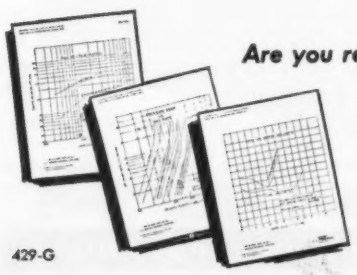
As you will note, the lowest HTU for raschig rings (about 1.17 ft) is developed at the 4' per second velocity specified in the question. While the HTU for Intalox Saddles at the same vapor velocity is somewhat lower (1.10 ft), the difference is hardly enough to warrant the higher cost of Intalox Saddles.

However, at 4' per second, the raschig ring packed tower is operating dangerously close to flooding as evidenced by the rapid increase in HTU with only a slight increase in vapor velocity. Practically, vapor velocity should be held between 3' and 3½' per second for an HTU of approximately 1.2'.

But, a changeover from ceramic raschig rings* to ceramic Intalox Saddles would do this: *it would permit an increase in vapor velocity to 5' per second for an HTU of 1 foot. This would mean a 20% increase in the number of transfer units and a profitable 30% increase in operating capacity.*

**Whether the change is made or not, it would be best to split the 30' bed into two 15' beds to obtain optimum performance.*





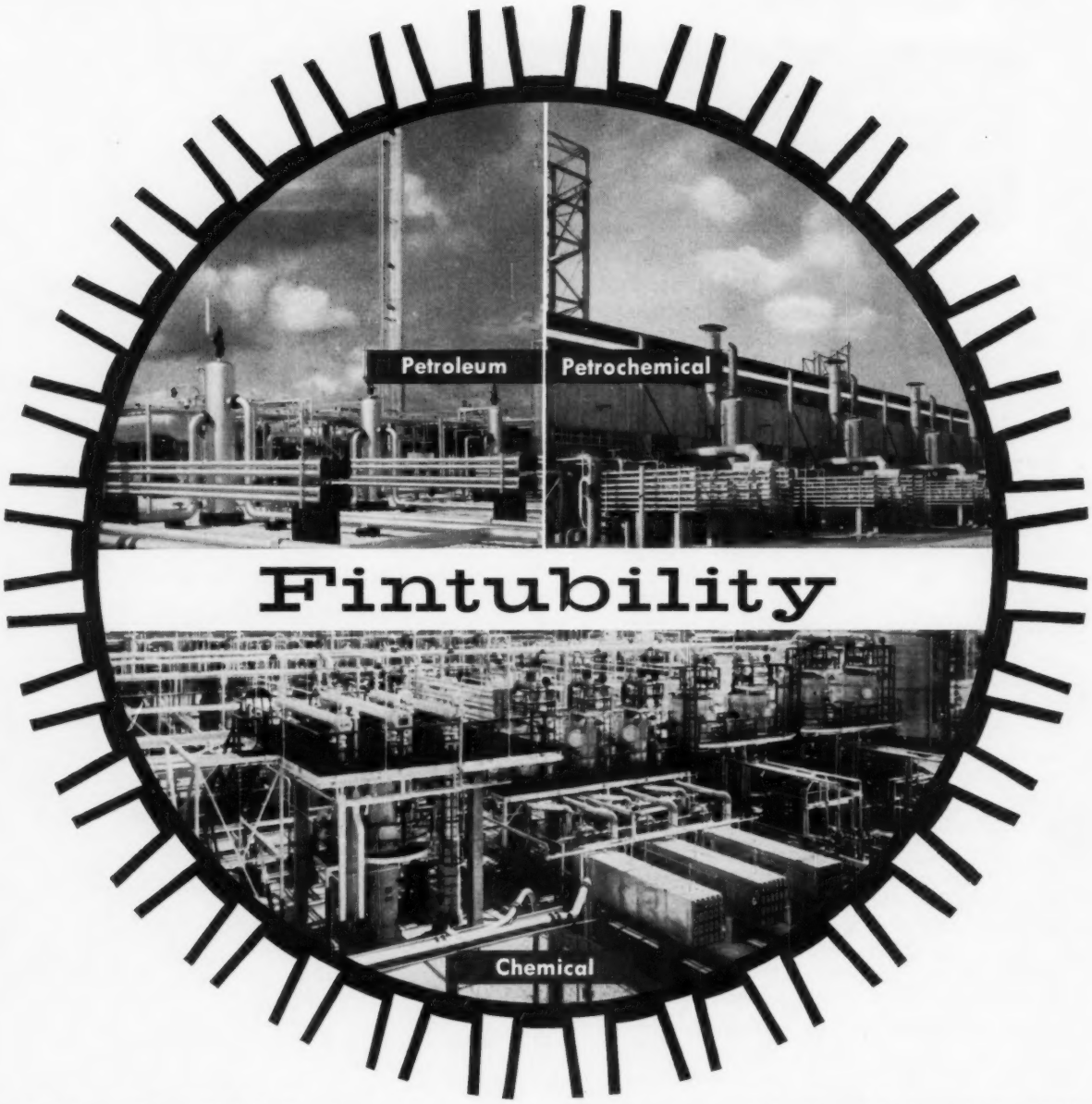
429-G

Are you receiving these reports?

We'll be glad to place your name on our list to receive these reports on packed tower performance as they are released. Write, on your letterhead, Engineering Dept., U. S. Stoneware, Akron 9, Ohio.

U. S. STONEWARE
AKRON 9, OHIO

For more data on advertised products, use cards, last page.



In 25 years Brown Fintube Company has become the dominant producer of fintubular heat transfer products for the petroleum, petrochemical and chemical industries. This rapid growth to maturity is traceable to the development of products and ideas that pay off for our customers.

Most of these products are based on our ability to conceive new ways to use the Brown Fintube. We like to call this "fintubility". Numerous solutions to industrial problems have been solved by the Brown Fintube since its extended surface allows the transferring of more heat in a very compact area.

Among the more noteworthy accomplishments of "fintubility" is the perfection of industry's only truly standardized heat exchanger. The Brown unitized heat exchanger system enables any company to meet all duties with one standardized unit. Other cost saving ideas are fintubular tank heaters that accelerate thermal flows for more rapid heating of tank contents; multitube hairpin heat exchangers for high-capacity applications; and low-cost indirect fired heaters for effective heating of gases, vapors and liquids.

If your heat transfer products do not utilize the greater efficiency of the Brown Fintube, may we suggest that you contact us. The people of Brown Fintube are always eager to carry on their research to develop better ways for fintubes to serve everyone. Brown Fintube Company, 300 Huron Street, Elyria, Ohio.

BROWN FINTUBE

SUBSIDIARIES: Brown Metals Inc., Brown Thermal Products Corporation, Brown Aluminum & Chemical Company

FACTORIES AND SALES OFFICES: Chicago • Houston • New York • St. Thomas, Canada • Birmingham, England • Dortmund, Germany • Paris, France • Mexico City, Mexico • Tokyo, Japan.

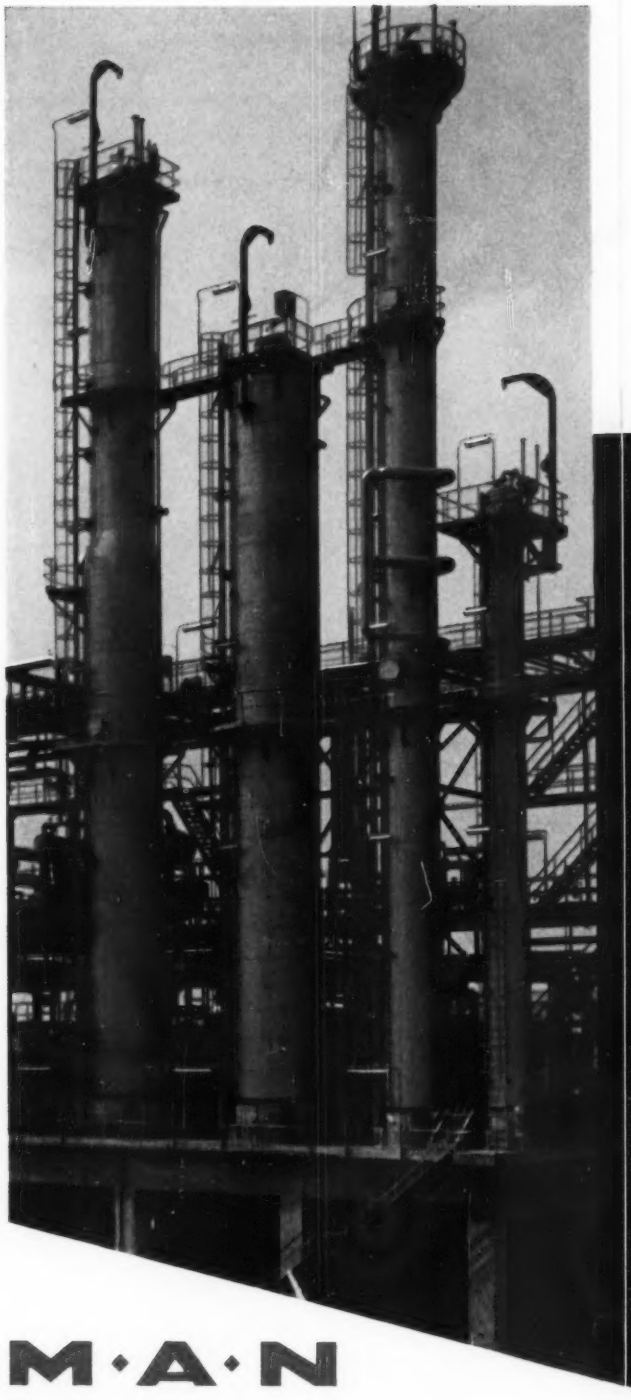
FINTUBILITY means Fintubes plus Engineering plus Ingenuity

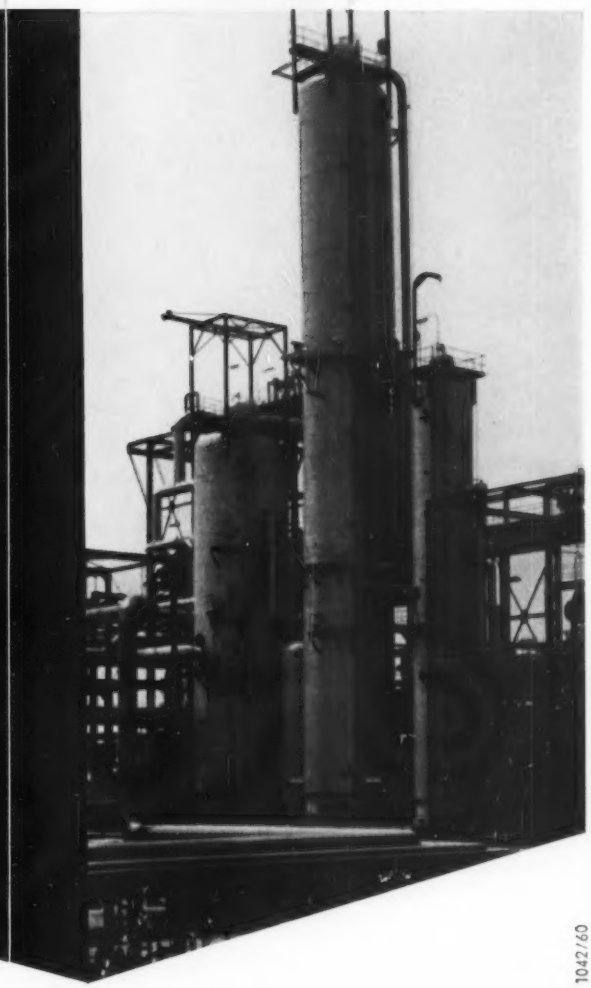
In 1959 we supplied to and erected on behalf of the Deutsche Shell AG. for their Godorf Refinery the

Distillation Unit
Gas Recovery Unit
Absorber Unit
Heat Exchangers and
Structural Steelwork.

Design and engineering work was carried out by the Bataafsche Petroleum Maatschappij N.V. and the Comprimo N.V., The Hague, whereas matters relating to purchase and inspection were attended to by Edeleanu GmbH., Frankfurt.

Our range of products also includes spherical tanks, pressure vessels and accessories for nuclear power stations, air coolers and regenerative heaters.





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Versatility of the Conoflow LB valve makes it suitable for any control service—easy or tough. Write for literature today or contact your local Conoflow representative (in all principal cities) for prices.

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The Most Experienced Hands in the Business . . .

Produce Corrosion-Resistant Welding Fittings that

Reduce Piping Costs

FEATURES

- Made by specialists in corrosion-resistant metals—in the business since 1927.
- Cold formed from forged or wrought metal, eliminating porosity—no castings are used.
- Produced of Stainless Steels 304, 304L, 316, 316L, 347, Monel, Nickel, and Aluminum.
- Stainless Steel, Monel, and Nickel fittings are annealed.
- Ends of all fittings are accurately machine tool cut—not ground.
- Regularly produced in all popular sizes and schedules.
- Made in conformance with A.S.A. and M.S.S. Standards—much closer to nominal dimensions than to permitted tolerance extremes.

We have had more stainless piping experience than any other fitting manufacturer—*since 1927.* And, we are the industry's only specialist in corrosion-resistant welding fittings. What's the dollar and cents value of this to you? Just this: *It reduces your installation and maintenance costs.* Here's why—

Because of our exclusive, patented cold forming process and other production procedures FLOWLINE Fittings are supplied much closer to nominal dimensions than to tolerance extremes permitted in A.S.A. and M.S.S. specifications. This high dimensional accuracy reduces fit-up time and assures optimum welding efficiency.

Because we specialize in corrosion-resistant welding fittings, our methods of forming, annealing, end finishing, etc. put the metal used in FLOWLINE Fittings in the best condition for corrosion resistance. This assures maximum service life.

For specifications of FLOWLINE Fittings write for Bulletins 416 and 417.

FLOWLINE CORP.

World's Largest Manufacturer of Stainless Welding Fittings

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F-12

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makes catalysts to your specifications

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Hydroforming	Dehydration
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Dehydrogenation	Isomerization
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Aluminum Isopropoxide		Aluminum Nitrate
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Copper Nitrate	Metallic Soaps (Cobalt, Manganese)	
Nickel Carbonate	Nickel Formate	Nickel Nitrate
Nickel Sulfate	Sodium Methoxide	Zinc Nitrate

Our experienced technical staff will assist you in developing the best and most economical catalyst. If you have a catalytic process in the development or production stage, a discussion with us may prove beneficial.

Write for FREE Booklet, "HARSHAW CATALYSTS"

HARSHAW

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1945 EAST 97th STREET • CLEVELAND 6, OHIO
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THIS NEW MEDIUM RANGE CENTER LINE MOUNT PUMP WILL HANDLE VIRTUALLY ANY LIQUID USED IN A PROCESS PLANT

PEERLESS PUMPS

Interchangeability feature of Peerless DMR pumps allows tailor made construction from standard parts to fit your plant's exact needs . . .

What's your pumping problem? Are you moving hydrocarbons, process chemicals or perhaps it's corrosive feedstocks that must be transferred. Then the Peerless DMR is the pump for you. Consider these reasons. The DMR will be assembled to handle your exact pumping needs. No need of compromising or re-vamping your intended plans. The DMR is a proven-in-use pump. You get a reliability factor you can be sure of. The integrated features of the DMR reduce need for large stocks of inventory parts—in some cases by as much as 85%. The DMR is an easy pump to apply. Installation is readily accomplished with little downtime. Long operating periods with minimum maintenance attention adds to the savings these pumps offer. And quick accessibility to interior parts simplifies servicing when and if required. What's more, the DMR has an attractive price tag that you will like. So get the full facts now. Write Peerless for a copy of Bulletin B-1610 which describes the new DMR pump in complete detail.

TYPE DMR CHARACTERISTICS

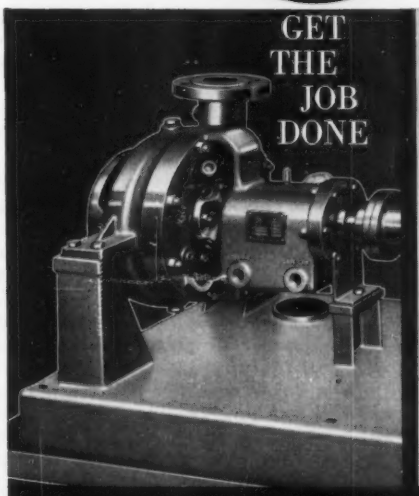
TYPE: Single stage, horizontal, end-suction, top discharge. **DISCHARGE SIZES:** 1", 2", 3" on 8½" frame: 1", 2", 3", 4" on 10½" frame. **CAPACITIES:** Up to 900 gpm. **HEADS:** Up to 450 feet. **WORKING PRESSURE:** Up to 300 psig. **LIQUID TEMPERATURE:** Up to 450°F. **CONSTRUCTION MATERIALS:** Any machinable metal. Cast iron, carbon steel, and stainless steel liquid ends are carried in stock as standard. **DRIVES:** Electric motor or steam turbine. **LUBRICATION:** Oil lubricated bearing frame. **LIQUIDS HANDLED:** Virtually all liquids used in refinery and petrochemical processing.

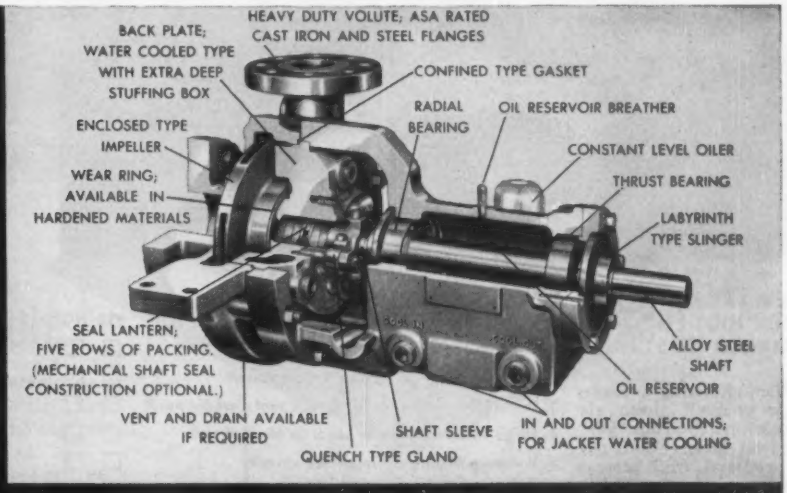
Putting Ideas to Work

PEERLESS PUMP
HYDRODYNAMICS DIVISION
Plants: Los Angeles 31 California, and Indianapolis 8, Indiana.

Offices: New York; Detroit; Chicago; Cleveland; Indianapolis; St. Louis; San Francisco; Atlanta; Plainview; Lubbock; Phoenix; Albuquerque; Los Angeles; Fresno.

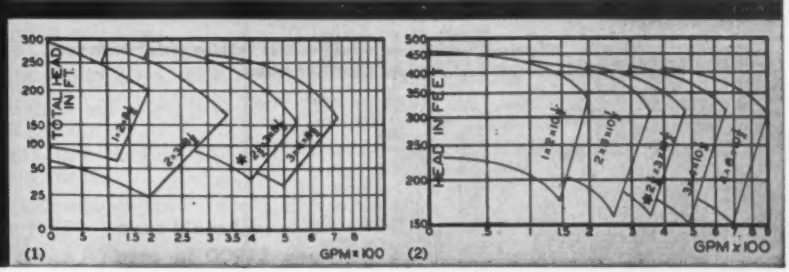
Distributors in principal cities.
Consult your telephone directory.





PERFORMANCE CURVES
PEERLESS TYPE DMR PUMPS
8½" and 10½" at 3500 rpm

Peerless DMR Pumps are available with both 1750 and 3500 rpm drives. Shown at right are typical curves for (1) 8½"—3500 rpm, (2) 10½"—3500 rpm.



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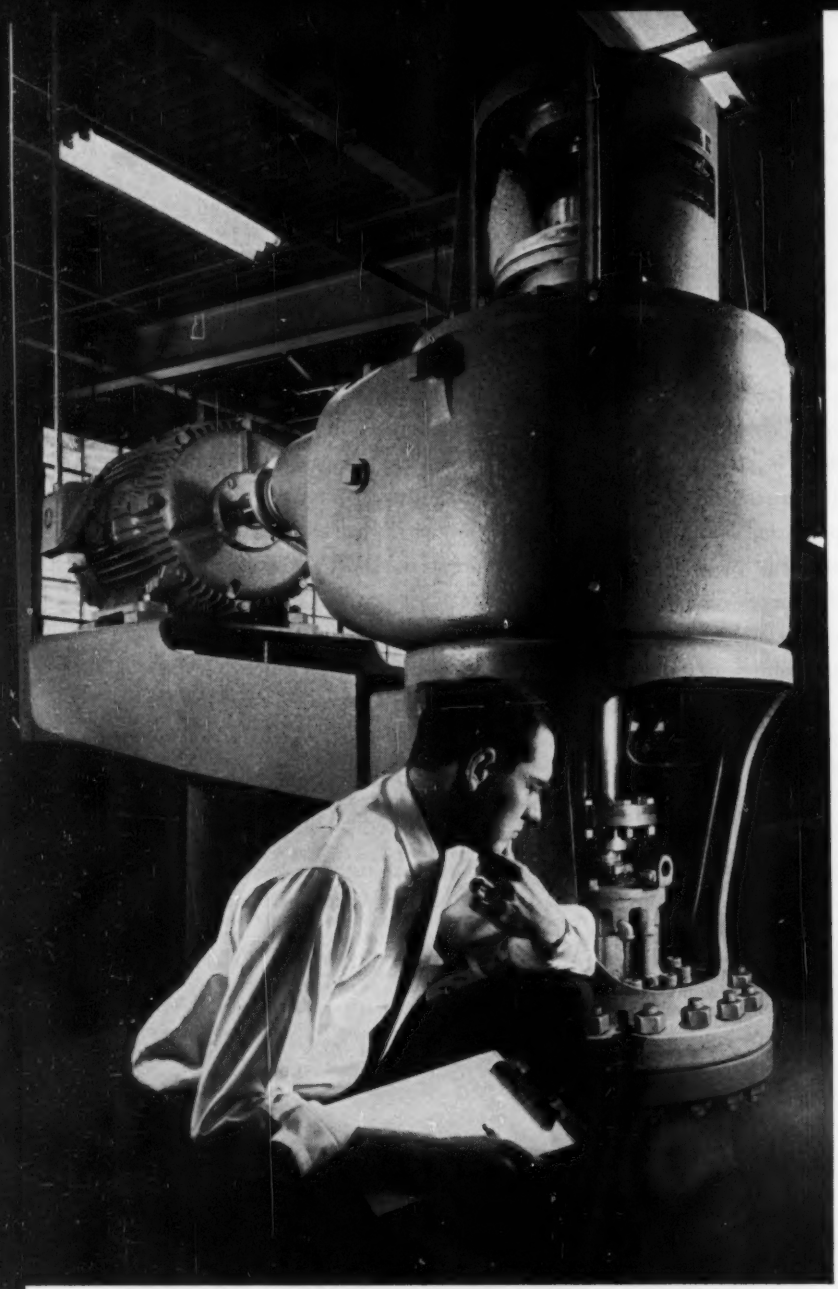


SEAL'S LEAKING!

How much will the downtime cost?

Even the best-running shaft seal on a mechanical mixer is going to wear out some day.

What you pay for the shutdown depends on how fast you can get back into production.

This is a good point to settle *before* you choose the mixer. The right answer can save you as much as *$1,000 per seal change.* (Based on conservative estimates of downtime production losses, plus direct labor cost. We've seen savings go much, much higher.)

The close-up below shows why you're ahead with a LIGHTNIN Mixer, equipped with a LIGHTNIN Rotary Mechanical Seal. Notice this patented seal is an integral cartridge unit. It saves buying separate seal parts and wondering if they'll work when you put them together.

The LIGHTNIN Seal needs no special skill to replace. It bolts in place without dismantling the mixer, without entering the tank. Aligns itself automatically. Doesn't have to be checked. You *know* it's going to work. (We never ship a seal until we've tested it statically and dynamically at rated pressure.) Gets you back onstream fast—without trouble, without tricky adjustments.

If you'd like to look further into the dollars and sense of pressure-vessel mixing with seal-equipped LIGHTNIN Mixers, your LIGHTNIN man has some interesting figures to show you. You'll find his name in Chemical Engineering Catalog and in the yellow pages of your telephone directory. Call him today. Or write directly to us.

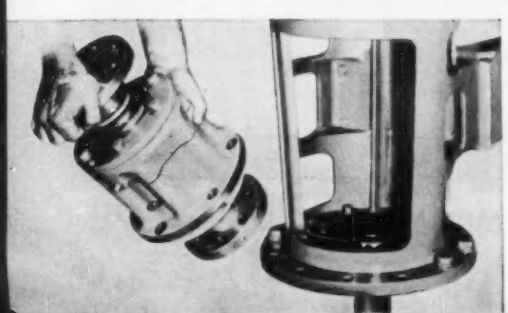
BEWARE OF "HIDDEN" MIXING COSTS

When choosing a mixer, ask yourself these six questions. Even one "yes" answer means you'll pay a needlessly high price—in lost production and in labor—to mix fluids.

To change or replace a shaft seal, will you have to:

	YES	NO
1. Check the new seal and sleeve for leaks?	☐	☐
2. Dismantle mixer or remove it from vessel?	☐	☐
3. Use skilled manpower to replace seal part by part?	☐	☐
4. Purge vessel in order to block up mixer shaft?	☐	☐
5. Uncouple mixer shaft *inside* the vessel?	☐	☐
6. Check alignment of the mixer gears, shaft, or bearings?	☐	☐

You avoid *every one* of these needless "hidden costs" when you mix with seal-equipped LIGHTNIN Mixers.



This seal could save you $1000 in case of a shutdown.

Lightnin® Mixers

MIXCO fluid mixing specialists

MIXING EQUIPMENT CO., Inc.
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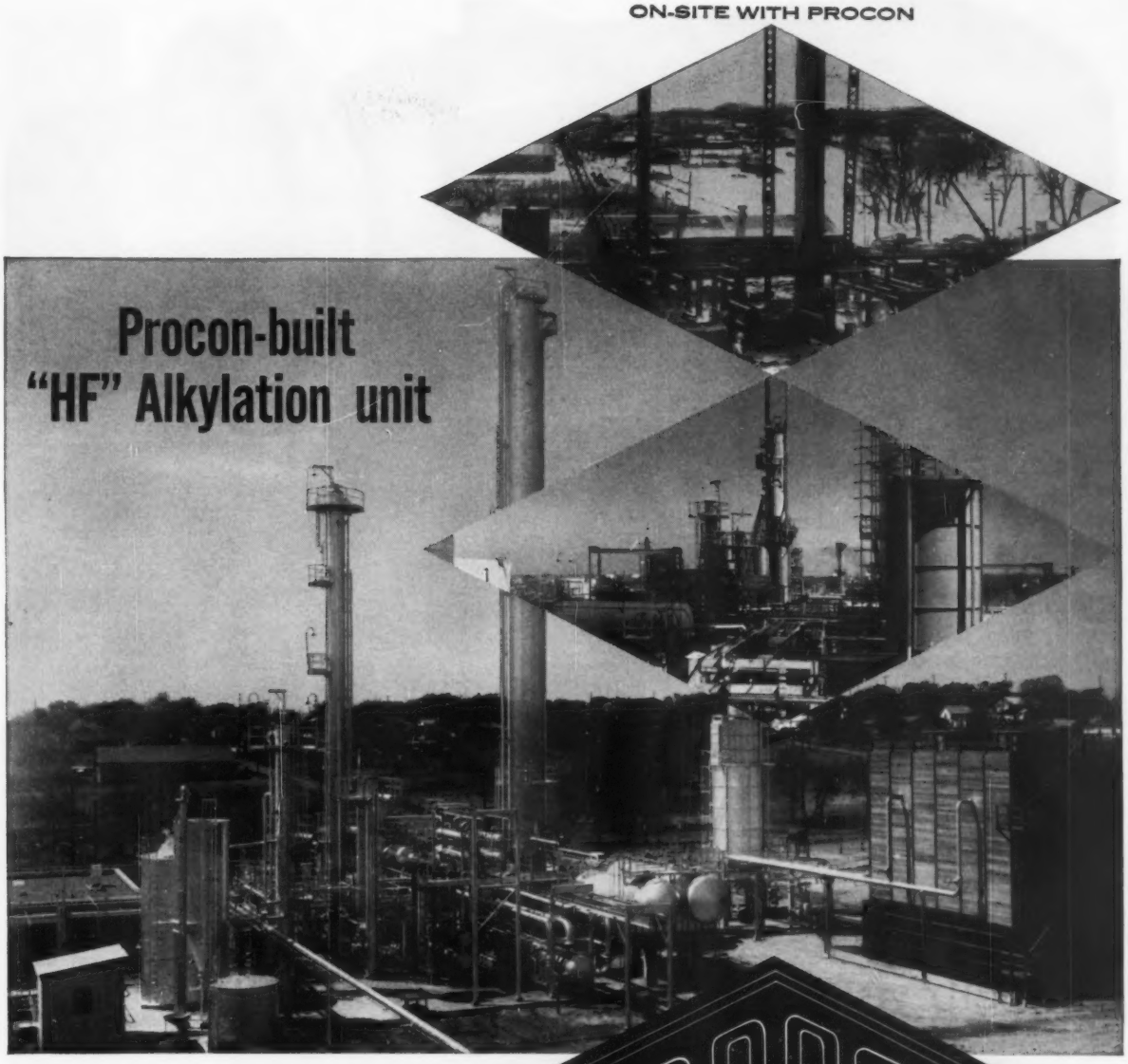
In Canada: Greey Mixing Equipment, Ltd.
100 Miranda Ave., Toronto 19, Ont.
In Europe: Lightnin Mixers, Ltd.
Poynton, Cheshire, England

ON-SITE WITH PROCON



. . . on-stream ahead of schedule

Maintaining schedule during the construction of a processing unit requires the precise co-ordination and timing of a series of design, engineering, procurement and construction details. But to complete ahead of schedule requires the extras in experience . . . in judgement, that save minutes and days. A right decision . . . a proper procedure . . . a new technique, these are the *experience factors* that help PROCON build better and on time.

Procon completed this "HF" Alkylation unit, built for Midland Cooperatives, Inc., days ahead of schedule. Midland located in Cushing, Oklahoma, uses the high octane alkylate to supplement its premium gasoline.

Turnaround, unit revamping, one unit or a complete refinery from the ground up . . . whatever your requirement you can trust the entire job to PROCON.

WORLD-WIDE CONSTRUCTION FOR THE PETROLEUM, PETROCHEMICAL, AND CHEMICAL INDUSTRIES

PROCON *Incorporated*

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For more data on advertised products, use cards, last page.

Burner flame on?

New FLĀMON Detector

can help you be sure!

Two FLĀMON Detectors installed for independent monitoring of main burner flame and pilot flame of a gas-fired boiler.

Properly installed, the FLĀMON Detector *responds only to the flame it surveys.* Glowing refractories—or flames from adjacent burners—do not produce false signals. Positive monitoring of each burner is assured. Absence or failure of flame is sensed and accurately signaled—and transmitted to control auxiliaries—without use of external relays or amplifiers.

Key to automation . . . the FLĀMON Detector provides the key to reliable automatic light-off and shutdown.

Provides wide temperature range . . . the FLĀMON Detector can be used in ambient temperatures from −20 to 150°F. Flame-sensing element withstands temperatures up to 500°F.

Allows easy inspection . . . quick-disconnect, keyhole mounting simplifies checking of lens condition and detector alignment.

Simple, solid-state circuitry . . . the FLĀMON Detector uni⁺ contains only 10 components.

Weatherproof construction . . . design of Bailey unit makes it suitable for outdoor installation.

Your local Bailey Engineer can give you a demonstration of the FLĀMON Detector. Call him, or write Cleveland.

CP 162-1

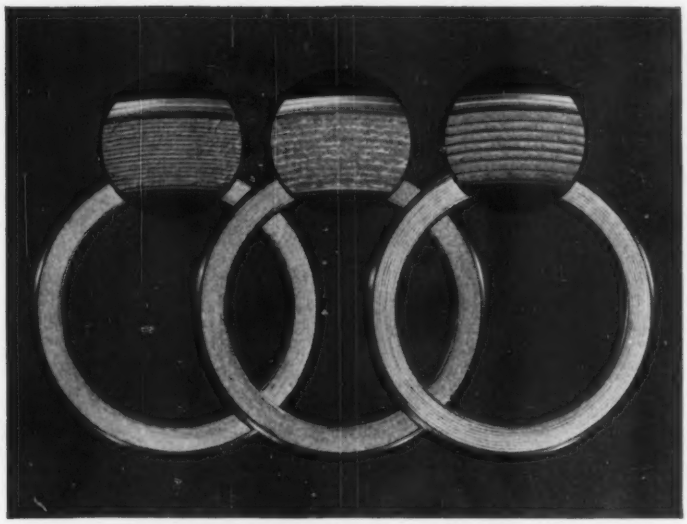
Chemical and petroleum division

BAILEY METER COMPANY

1043 IVANHOE ROAD • CLEVELAND 10, OHIO

In Canada—Bailey Meter Company Limited, Montreal

ENGINEERED GASKETS for Plant Maintenance



Exacting control of gasket density is obtained by varying the number of metal plies and filler material to seal a specific pressure.

Controlled density is the reason why Garlock *Guardian Gaskets offer you unusual sealing ability.** A series of V-shaped metal plies alternated with layers of filler form the "body" of GUARDIAN spiral-wound gaskets. The proper selected thickness of filler material and preformed metal, the number of laminations of filler and metal and the correct tension of filler and metal while being formed into a gasket are factors engineered to achieve the proper gasket density.

This controlled density—combined with the special V-shaped metal plies—allows the gasket to "breathe." Thus, a tight seal is effected at all times despite equipment or line expansion and contraction. In no other type of gasket is it possible to vary the compressibility to meet different pressure and bolt load requirements.

Complete range of sizes, shapes and wide temperature range are more reasons for specifying Garlock GUARDIAN Gaskets . . . 1/16″ thickness up to 6″, 1/8″ up to 30″, .175″ up to 60″ and 1/4″ thick up to 60″ depending on flange width. For temperatures up to +1900° F. with ceramic filler material.

Type CR GUARDIAN Gaskets are furnished with a cadmium plated centering ring for corrosion resistance and prolonged shelf life. Centering ring also is marked with the pressure series—assuring application of correct gasket density for specific pressure.

Convenient local stocks of most standard sizes are maintained at Camden, New Jersey, Cleveland, Ohio, Houston, Texas and San Francisco, California, for quick delivery.

GARLOCK

Find out more from your Garlock representative at the nearest of the 26 Garlock sales offices throughout the U. S. and Canada, or write for catalog AD-176, Garlock Inc., Palmyra, N. Y.
Canadian Div.: Garlock of Canada Ltd.
Plastics Div.: United States Gasket Co.

Order from the Garlock 2,000... two thousand different styles of Packings, Gaskets, Seals, Molded and Extruded Rubber, Plastic Products.

*Registered Trademark

Clear sparkling waters don't fool corrosion engineers

Coupled with temperature, pressure and velocity, some waters can chew up condenser tubes faster than you would believe possible. Minute differences in oxygen, chemical or biological content give each a corrosive character of its own that calls for well-informed tube alloy selection.

Case histories in which tube life has been increased from months to *years*—or from years to many *more* years—are packed in Bridgeport's files. The training and experience of our corrosion specialists can help match the best tube alloy to your water supply—whether potable, saline, brackish or polluted.

Write for information on Bridgeport's regular or Duplex tubes—or call in a Bridgeport man for quick and practical assistance on your corrosion, erosion or bio-fouling problems.

Bridgeport condenser and heat exchanger tubes in over 50 metals and alloys:

INHIBITED ADMIRALTY
INHIBITED ALUMINUM BRASS
INHIBITED MUNTZ METAL
70-30 CUPRO NICKEL
90-10 CUPRO NICKEL
DEOXIDIZED ARSENICAL COPPER
INHIBITED ALUMINUM BRONZE
RED BRASS
ALLOY 77 MERCURY BRASS

...plus **DUPLEX TUBES**...in combinations of the above alloys, with carbon or stainless steel, aluminum, Monel,® nickel...or other metals.

BRIDGEPORT BRASS COMPANY

Bridgeport 2, Connecticut

Bridgeport

WORLD RECORD IN ETHYLENE!

Stone & Webster clients produce over
3.2 billion pounds of ethylene annually
in 37 plants in 12 countries.

This world record of ethylene engineering
experience is available to you.
Call or write our nearest office.

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MILLIONS OF YEARS IN A MATTER OF HOURS

Anhydrite (white) replacing dolomite.

That's the effect Dr. Robert Sippel achieves when he foreshortens geologic time with the two-million-volt Van de Graaff accelerator shown with him in the picture at the right.

What's his hurry?

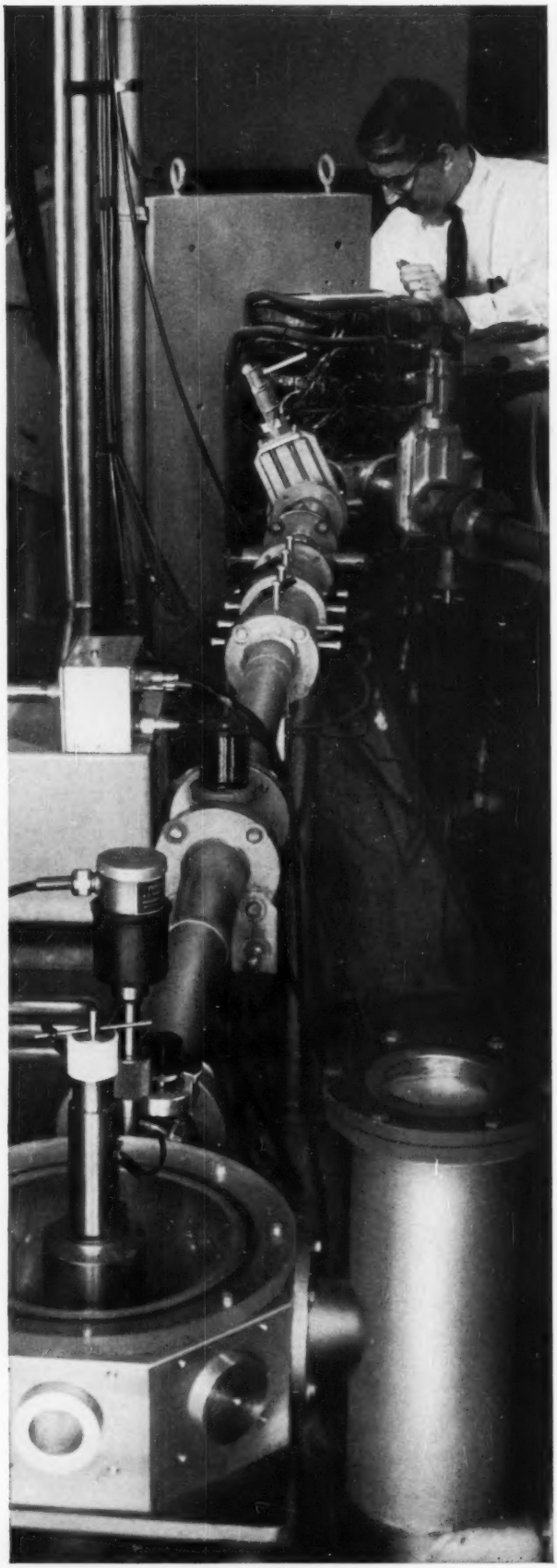
This: The Socony Mobil scientist wants to find just how, and how fast, one solid rock can be penetrated and displaced by another. Geologists call this "replacement." The small picture above gives a striking illustration of the invasion of one rock by another.

Dr. Sippel's interest is understandable. The way one kind of rock replaces another is closely linked with the formation of oil reservoirs. Better understanding of it will help in the endless search for new oil reserves. This is part of Bob Sippel's job as a scientist in Socony Mobil, the first company to apply the Van de Graaff instrument to petroleum exploration and basic geological research.

Dr. Sippel uses the high-energy accelerator to bombard solids with protons traveling at almost the speed of light. This bombardment makes possible extremely sensitive analysis. With this, Dr. Sippel can measure processes so slow in nature that even if you could watch for a million years, you wouldn't be able to detect any change. His studies are so sensitive that he can detect and identify a layer of atoms ten billionths of an inch thick.

Dr. Sippel is one of the 1,500 men and women engaged in Mobil's $25,000,000-a-year research program — in which imagination is turned into ideas, and ideas into better products and processes.

Probing the far frontiers of science pays off not only for Mobil, but for everyone who does business with Mobil — customers, employees, licensees, and investors.



Dr. Robert F. Sippel's interest in nuclear geology has a two-fold ▶ origin. At Rice University, where he received his doctorate, he concentrated on nuclear physics. His interest in geology developed after joining Socony Mobil, in 1954. Mobil scientists are encouraged to explore research areas stemming from their own special talents and interests.

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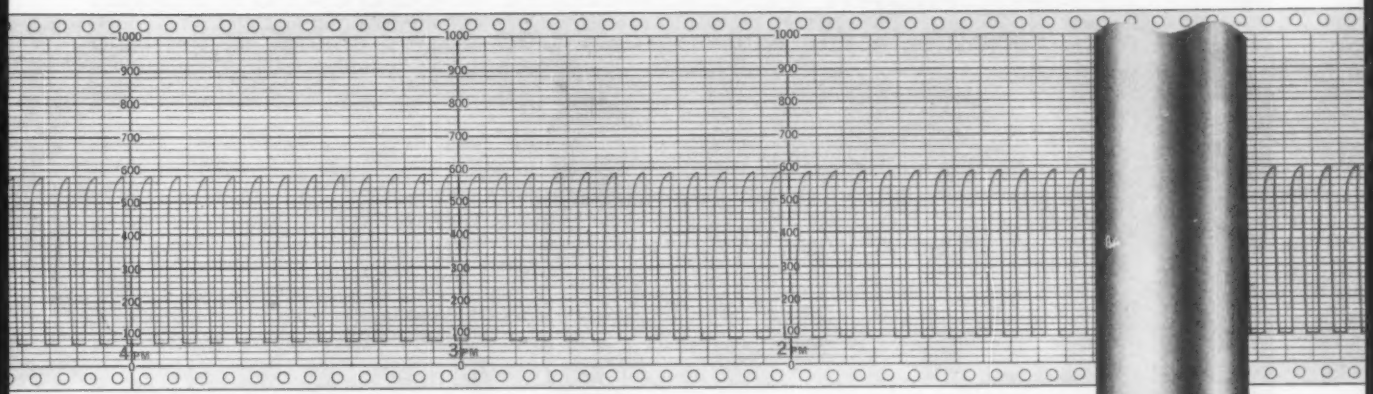
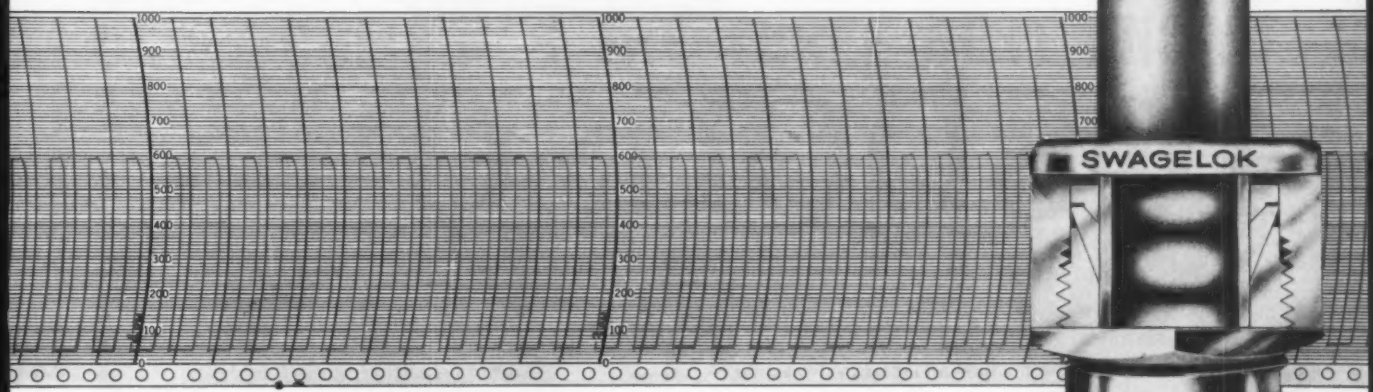
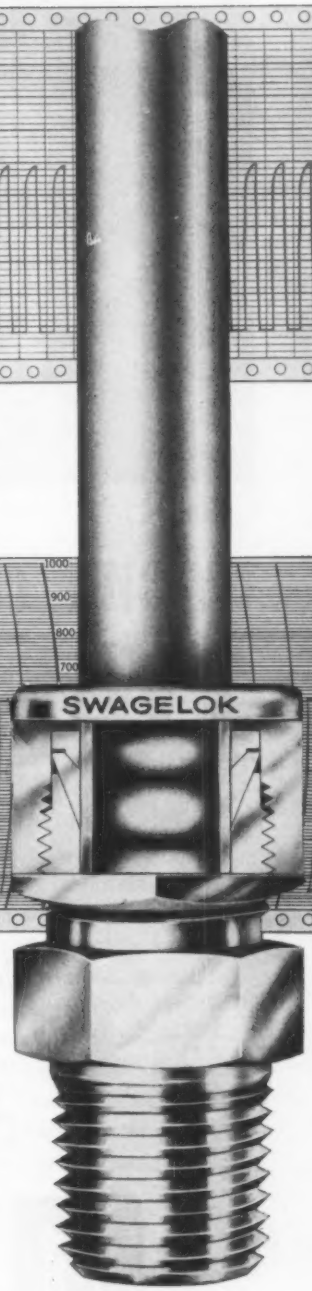


TEMPERATURE VS TIME RECORDING: The peak temperatures 580° to 600° F. occurred during the maximum pressure period. 750° F. steam was used but inability to keep insulation intact due to severity of the thermal shocks limited the maximum temperature. The minimum temperatures occurred during the cold water flush.





PRESSURE VS TIME RECORDING: The maximum pressures on the chart were produced by 600 psi superheated steam at a source temperature of 750° F. The minimum pressures were the result of opening the system dump valve and flushing with 50° F., 500 psi cold water.

The tests recorded on the above charts were conducted on one inch carbon steel hydraulic tubing (ASTM-A-179) using carbon steel SWAGELOK Fittings. Thirteen to sixteen SWAGELOK Tube Fitting connections were in the systems and 1200 severe thermal shocks were applied on each of two different tubing configurations without leaks or failure. The conditions used in this test were considered casualty or mal-operation conditions and are not recommended practice for any system design.

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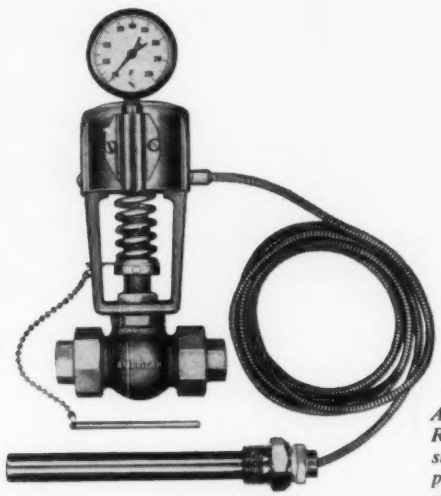

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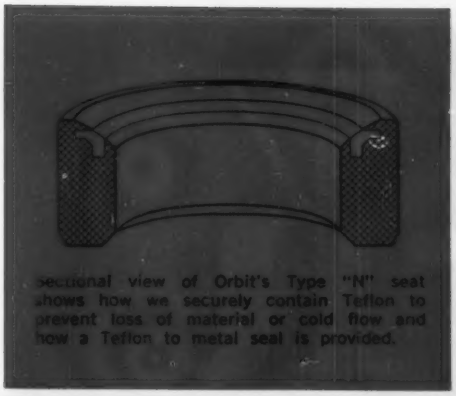
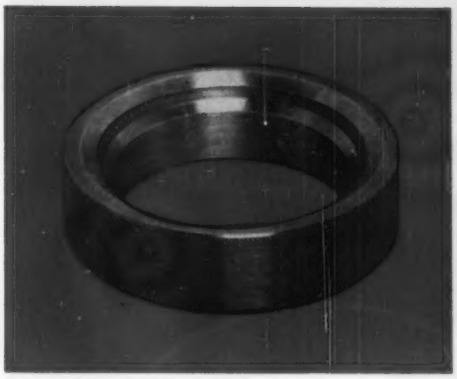
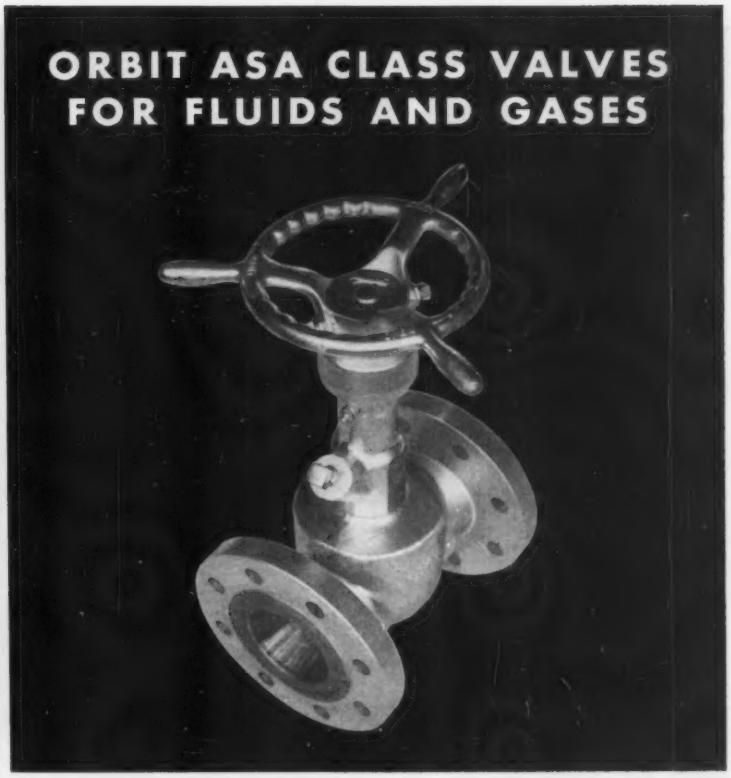


Sectional view of Orbit's Type "N" seat shows how we securely contain Teflon to prevent loss of material or cold flow and how a Teflon to metal seal is provided.





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* Teflon is duPont's registered trademark for its family of fluorocarbon resins, including FEP resin.

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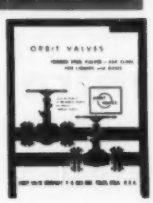

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ORBIT VALVES

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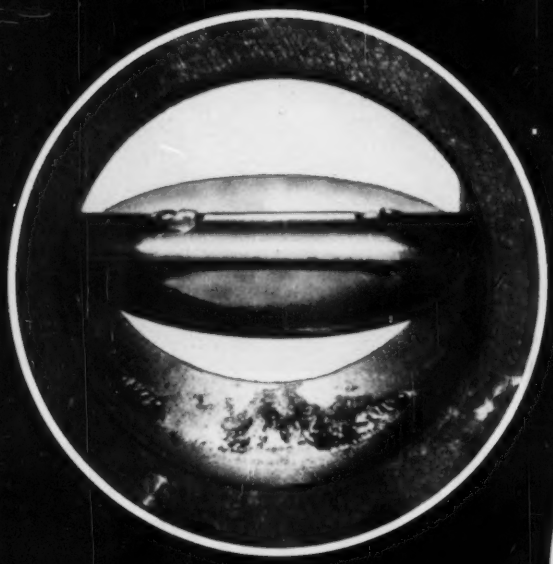

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keeps
carburetors clean . . .

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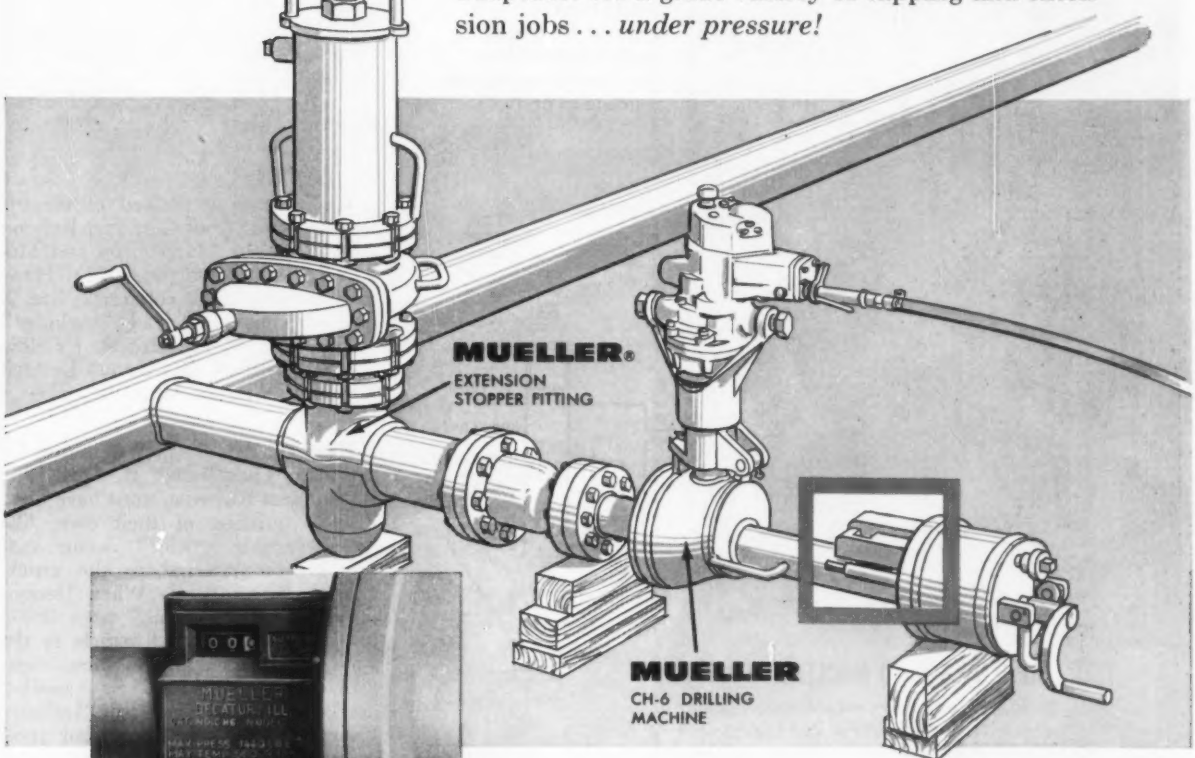

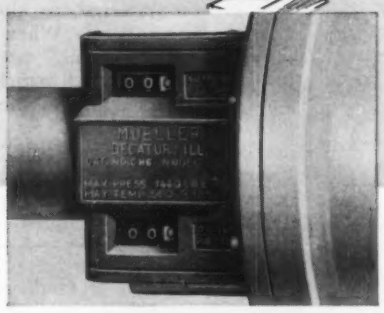

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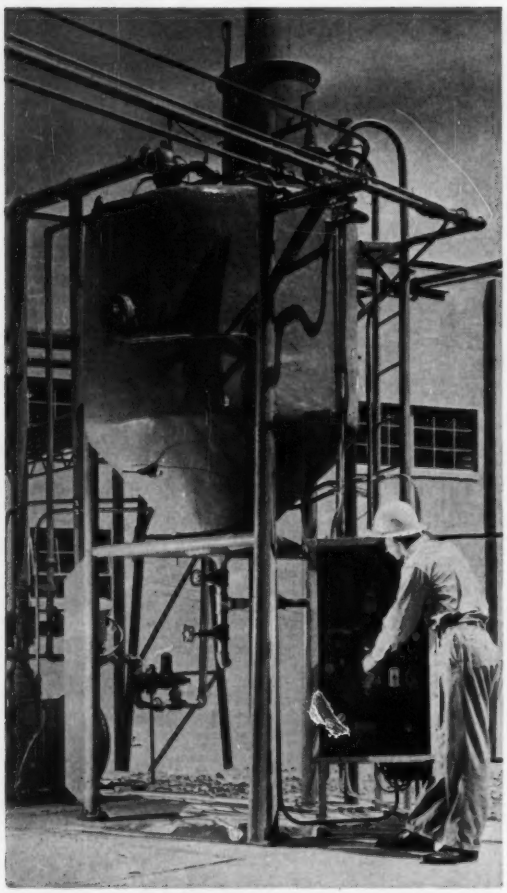

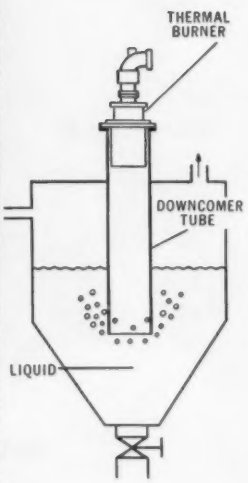

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Yep In November!

To The Editor:

We would like to inquire if PETROLEUM REFINER plans another Petrochemical Handbook Issue in the near future since we have had many requests for this reprint.

R. E. Kreider, Jr.,
Standard-Vacuum Oil Co.
White Plains, N. Y.

Yes, in November, Editor

Errata

To The Editor:

In our article, "What's New in Steam Methane Reformers," PETROLEUM REFINER, Vol. 40, No. 4, April 1961 page 169 an error appears on page 170.

Under "Why So Much Hydrogen," it should read, "Estimates place the total U. S. consumption of hydrogen at more than one trillion cubic feet per year."

Jack Tielrooy
Fullerton, Calif.

To The Editor:

We were very pleased to see the article, "How Well Can You Rely on Lab Tests," by Macpherson and McKay (March 1961, page 201). However, on page 203, column 2, line 2, "includes" should read "excludes."

Eric R. J. Oddie
BP Refinery (Kwinana) Limited
Kwinana, Western Australia.

Readers who answered Question 15, "Industry Quiz," page 21, April 1961 PETROLEUM REFINER, must have done a little quizzing of their own, like "Where's the article?" Seems that 15's answer referred to the article "Check These Points When Designing Knock-Out Drums," page 169—but there was no such article in the issue. Result: Right question, right article, *wrong* month. *For another* crack at the question see "Industry Quiz," page 21, and accept our apologies for keeping you waiting.

The Editors of Hydrocarbon Processing & Petroleum REFINER invite reader comment on topics of timely interest to the oil, gas, and petrochemical processing industry.

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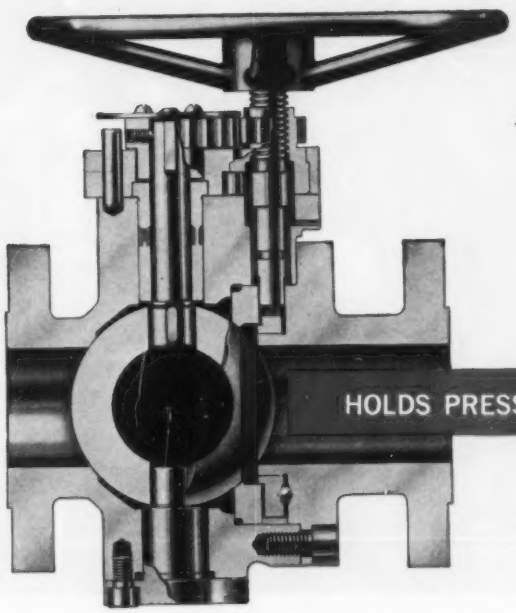

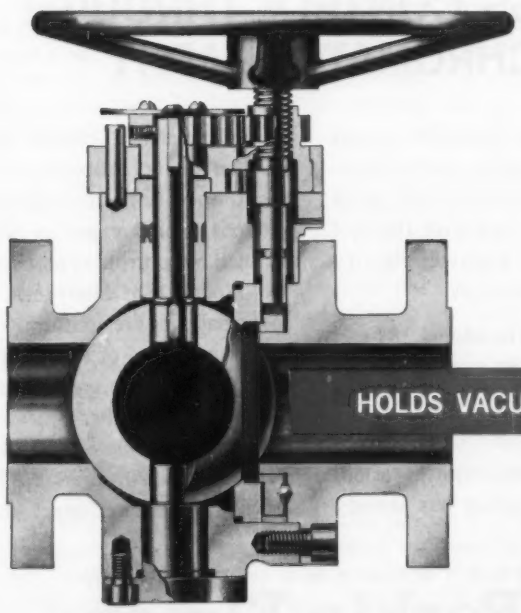

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Controlled sealing . . . a new concept in valve design . . . is the secret of Hydril's tight, bubble-proof shutoff. Hydril Ball-Plug Valves always seal positively against pressure from either direction—or against vacuum—because the fully confined packing ring is mechanically compressed between plug and seat when the valve is closed. This tightly compressed gasket type seal easily bridges clearances between parts as well as surface imperfections. Result: seal efficiency is unimpaired by prolonged hard usage, by rust or sediment.

Design of Hydril Type "K" Ball Plug Valves assures minimum maintenance costs. Non-lubricated, they employ no sealing lubricants. There's no sliding friction between plug and body to produce wear and abrasion.

The spherical plug is mounted on accurately positioned bearings, maintaining a minimal controlled clearance between plug and body. This contributes to easy, free-turning operation as well as to long service life.

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Hydril valves are available in a wide range of sizes and ratings. Worm-gear and motor-operated models can be supplied. Get the full story on Hydril Valves from your nearby representative . . . or write Hydril Company for free Catalog No. V-60.

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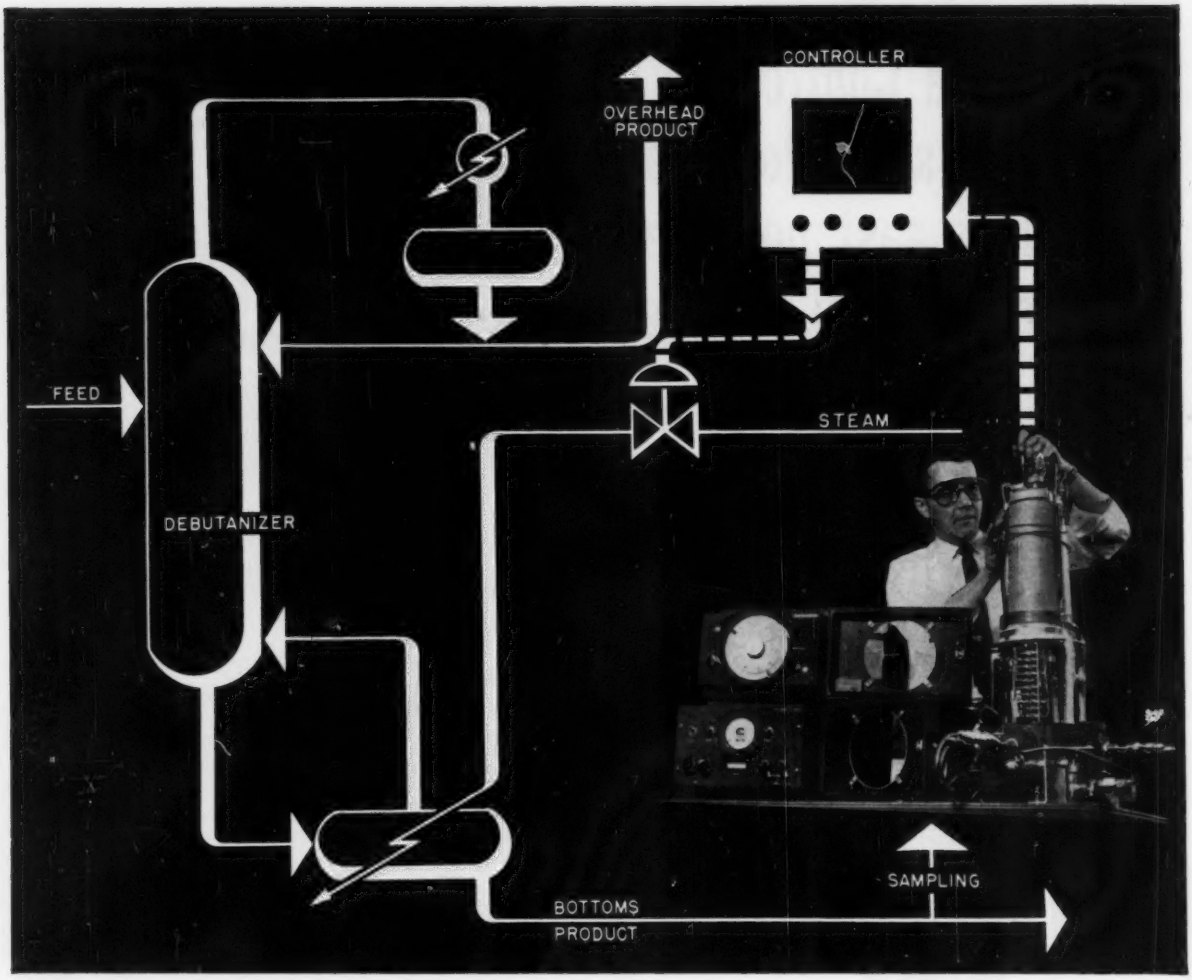

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This new system is characterized by:

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HOW TO RETIRE

By Forrest E. Gilmore

If you've thought much about the day you step into the new world of retirement, chances are you've asked yourself a million questions about life expectancy, leisure time, savings, health, etc. The success of your retired life depends largely on how well you resolve these questions *now*. In this report, written by a retiree who did plan ahead, you'll learn how to set realistic goals leading to health and happiness. **Charles H. Vervalin** MANAGEMENT & PERSONNEL EDITOR

1. Preparing for Retirement

"Grow old with me! The best of life is yet to be—the last of life for which the first was made."

Robert Browning

Some people think the problems we meet are like some people we meet; if we fail to recognize them they pass on without disturbing us. Failure to recognize your retirement problems will avoid them only for a time. The longer they are put off the more difficult and unmanageable they become. If you want to live a full life and avoid the common pitfalls that lead to unhappiness, poverty, ill health and premature death, you will need to plan your retirement as carefully as you planned your career.

In considering the importance of preparing for retirement, you need to realize that, along with almost everything else that affects you, retirement is rapidly changing. First, there is the gradual increase in life expectancy and the probable continuation of this increase. In which portion of your life are these years added? Certainly, considerably at the rear end, i.e. after your retirement. This period may soon become almost as long as your so-called productive years.

Second, with Social Security, company sponsored pensions and other means of providing retirement income, you can effectively plan your financial security and for enjoyable activities after retirement.

And, third, by utilizing known health practices, you can almost certainly enter into retirement with zest for the new freedom to do largely what you please. So, the retirement years become increasingly important in your scheme of things. *They may well be the best years of your life.*

There is a saying that, "Nothing is sure but death and taxes." For almost everyone, retirement, either forced or voluntary, is just about as sure. However, if you wait until you retire to begin preparing for it, you are almost certainly doomed to disaster. The sooner you start, the better your chances to reach your reasonable goal—a long, happy, rewarding, retired life, doing largely what you please.

YOUR FUTURE

Start Early. Every person, like every other animal, is almost continually preparing for the future. The baby and the small child is preparing for life by growing, experiencing sensations and gaining understanding. Later, as a school child and as a teen-ager, he is taught things his teachers believe he needs to cope with life problems. He learns to work and compete with others, physically and mentally.

Then as an adult, he begins to think for himself, to study and practice the things he needs in his occupation. He accumulates property, obtains a wife and children, and prepares the children for their future. In this period between adulthood and old age, when he is still able to do so, the wise man thinks about (and solves) most of the problems he will have planning for and experiencing retirement.

Usually, the earlier you start on any program the better it can be executed. It has been well said that the biggest problem in the world could have been solved when it was small. This is particularly true of retirement

The world's softest cushion

problems. They involve your habits, thrift, philosophy, knowledge and talents, likes and dislikes, friends, innate abilities, health, religion, hobbies, occupation, inherited durability and many others.

Don't Put It Off. You have so much time between 20 and 65 to prepare for your future after retirement, and, preparation for the immediate future seems so important that retirement plans are apt to suffer from lack of attention and to be put off until later.

The habit of putting it off grows until it is irresistible. Then, before you know it, the retirement problems are here. Since so little is usually known of them (except perhaps the money problem on which so much stress is placed) they catch you unprepared. You're thrown hard. You may think you are an exception to this, that your habits of solving problems in business will make it easy to solve retirement problems when you get to them. This is not so. The problems in your business or professional career are not like those in retirement. The latter problems begin to develop long before you retire and can be solved only then. Many able business men utterly fail at retirement. This means unhappiness for them and their wives and frequently early death.

MEANING OF RETIREMENT

The Great Challenge. Today, more and more people retire into almost absolute idleness. The work they had been doing was completely specialized. Perhaps it involved only a small part of a manufacturing process, or was peculiar only to the business in which they worked. Thus, it could not be carried on at all in retirement. During their working years it had absorbed their entire attention, so they had not developed wide interests nor hobbies to take up their time after retirement.

Many times I have been asked what I was going to do after retirement. When I replied that I had so many things I wished to do if I could only find the time, the inquirers would almost always say something like this: "You are very lucky to be interested in so many things. All I know is how to do this job I have been doing for so many years." I found an amazing lack of retirement plans and understanding of the need to prepare for retirement among business friends. This made me decide to find out all I could about retirement, and write about it.

Get On The Right Track. Self understanding contributes to happy retirement. Some people can happily retire, to spend almost all their time on one or more hobbies. Others have a craving for accomplishment or a feeling of responsibility toward some duty, such as social service. So you must study yourself, perhaps even change yourself by mental preparation. You must formulate retirement plans suitable for your financial, physical and mental abilities. You will want to be sure you don't waste time doing the wrong thing after you retire. The time for experimentation with your time is largely over with retirement.

DOING AS YOU PLEASE

Your Bondage. Most of you can't do what you please except during your annual vacation. Each time you have almost a full year in which to plan what you are going to do with this precious time. Since you and your wife have relatives and friends you feel duty-bound to visit, even your vacation is seldom free for you to do just as you please. You and your wife may wish to take a trip, which you could afford were it not for the children and their needs. But being good parents you let family needs take precedence over your wishes.

With retirement you are ready to live a life of your own, going where you wish and doing as you please. Your biggest danger might be expressed briefly, "too much of a good thing." You may have thought you could play golf or fish practically all the time. Some people can, but they are exceptions.

I once knew a wealthy man who thought he would retire to a life of play. After a year he was back in business. Asked why he had changed his mind, he said his biggest trouble was to find friends to play with. He didn't seem to enjoy strangers as much as he had thought he would. "After all" he said, "for sustained interest it is hard to beat business." This man needed to retire to some business. He did! It was one that gave him plenty of time to play with friends who would have similar business problems to discuss, and at a time they were available.

Your Freedom. Most people don't do the work they are best fitted for during their normal working lives. It is doubtful you have realized your youthful dreams, although they probably indicated the nature of your greatest talents. These unused talents and latent skills should be revived, cultivated and evaluated years before you retire. They may become hobbies or cultural interests. Or, they may become a side business which you can employ someone to run for you until you are ready to take over.

Perhaps you can get your job changed to one where your latent abilities and skills can be used to your employer's advantage. This will bring you greater happiness while helping you prepare for retirement. For example, while you are employed as a routine production man you may find your knowledge of production supplementing a natural selling talent to make you a good salesman for your company. Salesmen's interests usually prepare them well for retirement, and for going into some business of their own requiring salesmanship, should they desire.

The greatest benefit of retiring for those who are prepared is FREEDOM. As William Cowper once wrote:

"Freedom has a thousand charms to show,
That Slaves, howe'er contented, never know."

In determining my retirement goals, I decided the first and most important one was to live as long as possible. The second was to make my retirement period a contented one which required that it be free of stress, anxiety and pain. The third was to obtain a reasonable amount of accomplishment. To reach these goals many problems had to be understood and solved. I made a written list of them, and of the factors affecting their solution. Then, I started learning all I could about them. I read books on retirement, articles in magazines and papers and talked with friends—retired and otherwise—about retirement. Then, I thought about the things I had learned as they applied to me. Some of the principal problems I considered follow:

1. **Physical Health**
   a) Proper food
   b) Avoidance of injurious habits
   c) Proper exercise
   d) Physical checkups
   e) Proper medical and dental attention
   f) Good habits
   g) Knowledge of diseases and how to avoid them

2. **Mental Health**
   a) Avoidance of stress
   b) Appreciate those I work with
   c) Cooperation with others
   d) Cultivate serenity
   e) Do not attempt too much
   f) Be sincere in all things
   g) Develop interests in many things
   h) Continue mental growth by observing and learning

3. **Spiritual Health**
   a) Cultivate faith
   b) Love my neighbor
   c) Help others

4. **Financial Health**
   a) Regular savings habits
   b) Thrift in buying
   c) Good investments
   d) Proper insurance
   e) Future income from investments
   f) Annuities
   g) Social Security
   h) How to earn money after retirement

5. **Recreation**
   a) Skills which can be carried into retirement
   b) Interests which can be carried into retirement
   c) Cultivation of new interests

These four healths, as well as recreation, are largely interdependent. Each contributes to the others. Without mental health it is difficult to have spiritual, physical or financial health. Without proper recreation it is difficult to have good mental health. Always bear these relationships in mind when planning your future.

2. How Long Will You Live?

"If you do not think about the future you cannot have one."

Galsworthy

YOUR CHANCES OF BEING ALIVE AT 65

What are your chances of being alive at 65 to collect that pension you may now be building up? How much longer after that will you probably live? The Metropolitan Life Insurance Co. has published much data on life expectancies and mortalities at various ages. They also have data on mortalities from various diseases, and other matters of interest to those planning for retirement, in statistical bulletins.

From them we find it is probable that 68 out of every 100 young men of 18 just starting work will live to retirement age. And, 90 of every 100 workers now in their late 30's and early 40's will be around to collect pensions. At age 65, men, on the average, can expect to live to 78 and women to 80½.

However, these probabilities are based on projections of past experience. There is reason to believe they may be greatly exceded. Should preventative therapy or cures be found for the diseases of the heart and blood vessels and cancer, these life expectancy forecasts will be much too low. Those of you who, through proper living and natural health, go into retirement in excellent health and who take advantage of the present knowledge of geriatric care, can expect to live far longer than the average. This is so even if no major breakthrough in the scientific treatment of the major killing diseases of old age occurs.

As famous a doctor as Dr. Edward L. Bortz, past president of the American Medical Association, says the life span in this country will increase to 100 years

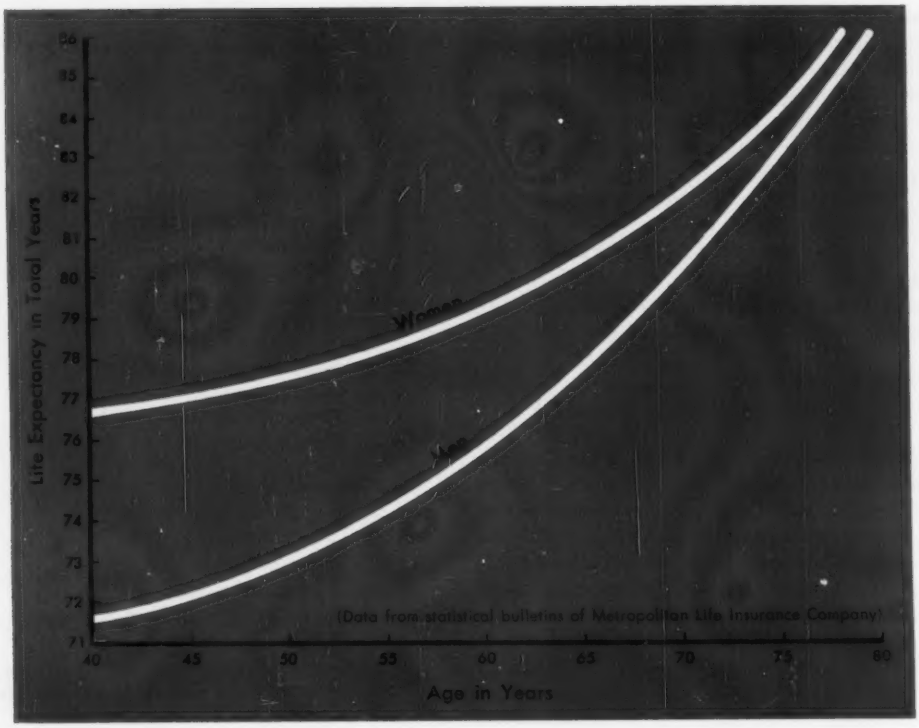


FIGURE 1

within 20 years. There are almost one million persons over 85 years of age in this country and about 4,500 of them are centenarians.

YOUR LIFE EXPECTANCY

Your Basis For Planning. In planning for your future retirement, you need to know (1) how long you and your wife will probably live, (2) the chance you have of reaching the age of retirement, (3) how long you can expect to live after retirement, and other vital statistics. Any prediction of the future must be based on past experience, and is apt to be changed by medical breakthroughs—and even disaster, such as nuclear war.

However, you can only do the best you can with available information. You must use your own judgment about any allowances for changes resulting from new medical and health discoveries, and for your own durability as compared with the average. To help you with this, see Figure 1, taken from Metropolitan Life Insurance Co.'s Statistical Bulletins. Here you can easily get information applicable to yourself.

Figure 1 shows curves of the life expectancy of white men and white women for ages ranging from 40 to 75 years. Probably most men, if in good health and heeding advice in this article, could well expect to live as long as the Figure 1 shows for white women, and white women somewhat longer.

Figure 2 shows the chances of reaching 75 at various ages ranging from birth to 75 years. Note that the chances do not increase rapidly between birth and age 40. This is because so few people now die before they reach age 40, and especially between the ages of 10 and 40. After 40 the mortality rate steadily increases, as shown in Figure 3, throughout life. After the first

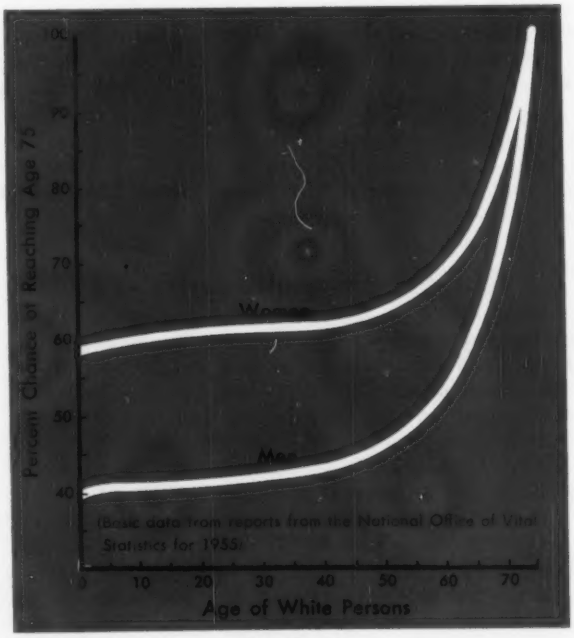

Percent Chance of Reaching Age 75
Women
Men
(Basic data from reports from the National Office of Vital Statistics for 1955)
Age of White Persons

FIGURE 2

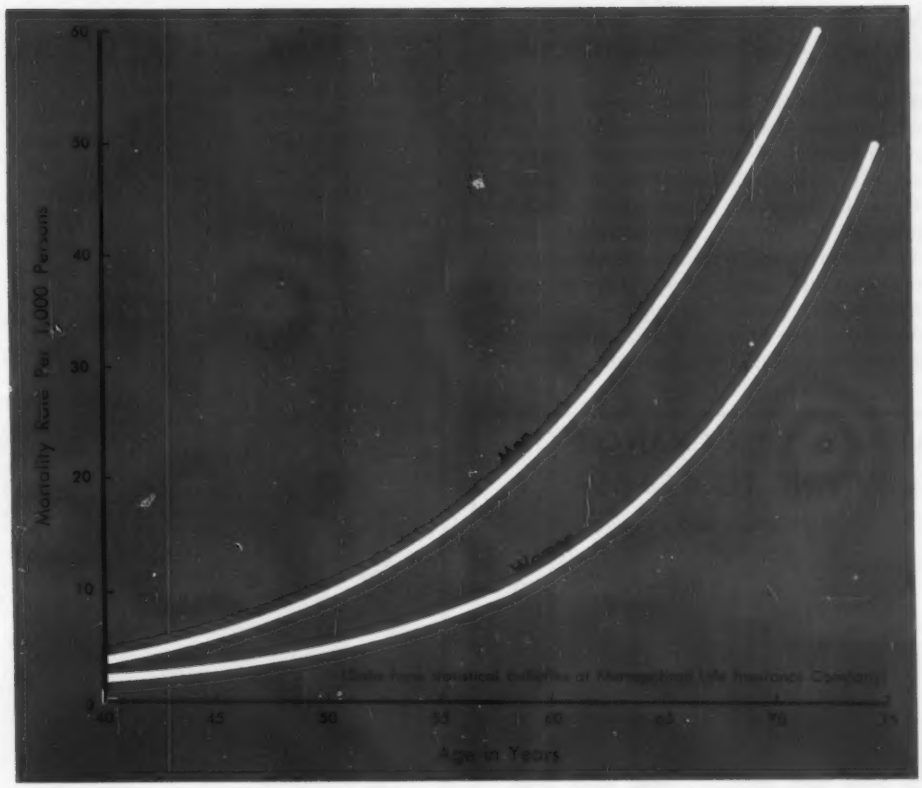


FIGURE 3

two years following birth, the mortality rate of people in the United States decreases to about 0.8 persons per thousand per year. It goes even lower to 0.4 per thousand by the eighth year, starts slowly rising after the eleventh year until it reaches 3.1 per thousand in the 40th year.

Life expectancy at birth has increased 2½ years since 1947 and 20 years since 1900. It has increased about 65 percent since 1847. However, the gains in longevity in recent years have been greatest at the younger ages. Since 1900 about 11½ years have been added to the life expectancy at age 5, nine years at age 21 and five years at age 40. At age 65 the increase of life expectancy since 1900 has been only about two years.

Further increases in life expectancy are expected. But in the absence of major breakthroughs in the prevention and cure of the major killing disease of old age, such as diseases of the cardiovascular-renal system and cancer, they will be smaller than those achieved in the past 20 years. The Social Security Administration predicts the expectation of life at birth in 1975-80 will be 73 years, or a little less than four years more than it now is. These projections indicate that even by the year 2,000, the average length of life will be little more than 74 years.

Table 1 shows the percentage chance of reaching age 65 for white men and women for various ages, as of 1956.

Table 2 shows the percentage chance of reaching 85 for white men and women after 65, as of 1956.

These figures and tables show that people need to provide for many years beyond their main working ages. According to them, more than 30 percent of the men who reach age 23 will fail to reach the normal retirement age of 65. This shows how important it is to take care of your health and provide for your wife in case of your death. Her chances of living over 65 are much better than yours.

CAUSES OF DEATH

During the first six months of 1959, the mortality, annual rate per 100,000 industrial policy holders of the Metropolitan Life Insurance Co., from all causes, was 698.1. Table 3 shows what caused the indicated percentage of deaths.

Over half of the deaths were from diseases of the cardiovascular-renal system. When deaths from cancer are added, these account for over 75 percent of the deaths. Among persons over 65, these two account for a much higher proportion of the deaths. They are the great killers of the aged. It used to be said that pneumonia was the old folks' friend because it took so many of them who were ill. Today, it and influenza together account for only 3 percent of the deaths among the

policy holders. With proper attention and the use of antibiotics, this percentage could be greatly reduced.

Cancer The Killer. More than half the cancer deaths in the United States are in the over-65 age group. Since this group contains about 9 percent of the population, the mortality rate from cancer in it is over ten times as great as in the under-65 age group. Both incidence and mortality from cancer increase steadily during adult life, reaching their maximum in the oldest people. Also, the incidence and mortality of cancer at ages 65 and over is much higher among men than among women.

It is estimated that one in every four persons reaching age 65 will develop cancer. The mortality rate from cancer in men is rising. This is almost entirely due to the increase in cancer of the respiratory system. In women there has been an increase in respiratory cancer, but not as pronounced as among men. Perhaps they have not been heavy cigarette smokers as long as men.

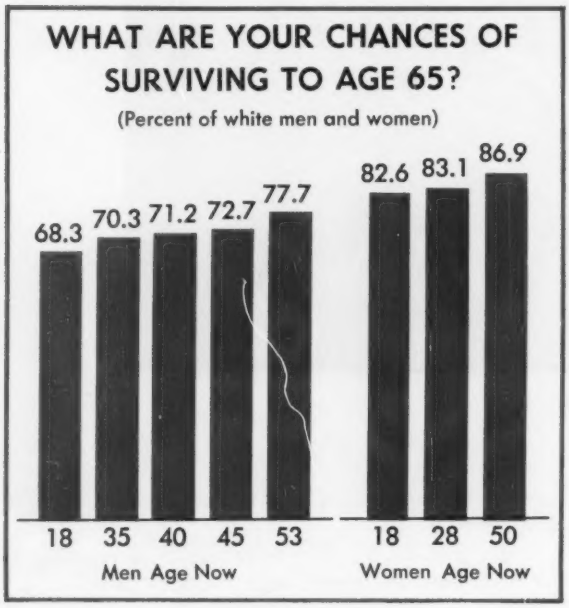


TABLE 1

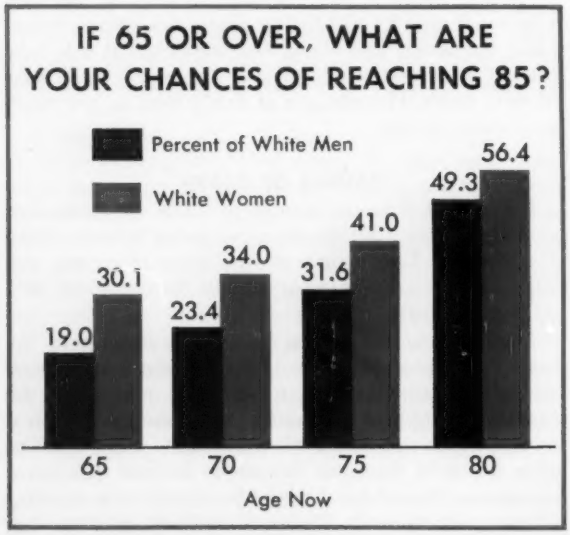


TABLE 2

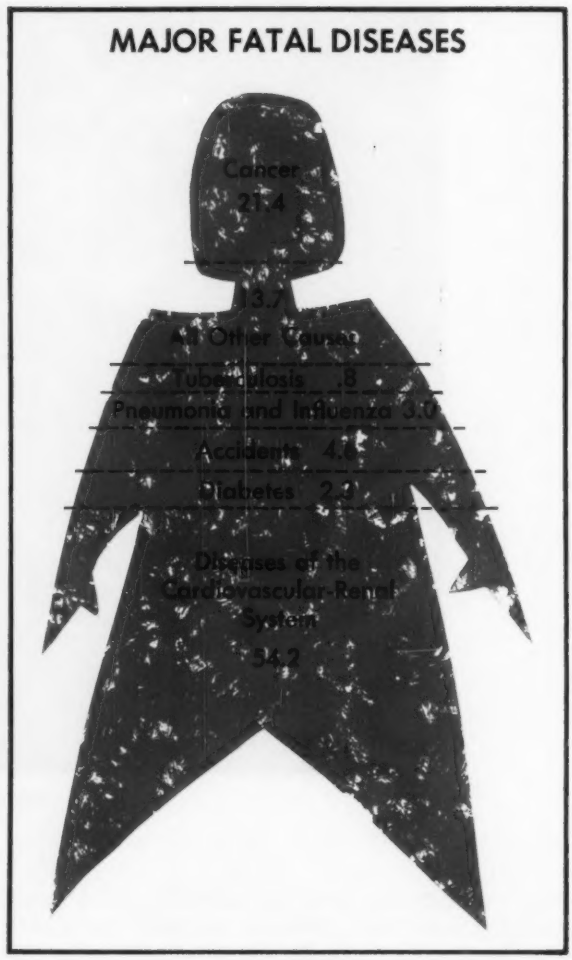


TABLE 3

Mortality from cancer in various organs among elderly white men (taken from the National Office of Vital Statistics, Vital Statistics of the United States, 1954) is shown in Table 4.

This shows that the rate of mortality among old white men from cancer of the digestive organs and peritoneum does not change much between the ages of 65 and 85. It gradually decreases in the respiratory system, until at 85 it is less than one-third that at 65. And, with cancer of the genital organs, it rapidly increases until it is a little over double the rate at 85 than at 65.

Cancer is one of the foremost problems of old age. But at advanced ages, early detection can often lead to successful treatment or relief. Periodic health examinations of the elderly are a means of early detection. There is no room for complacency or neglect in the early detection and treatment of cancer on the assumption that little can be done about it in elderly people.

WHY YOU MAY LIVE LONGER

Medical Progress. Over 90 percent of the drugs now prescribed by doctors were not known 20 years ago. During that time certain diseases have been almost completely wiped out. Others have been rendered almost impotent. Three million of us now alive would otherwise be dead were it not for sulfa drugs and antibiotics.

Pneumonia and influenza, tuberculosis and gastritis accounted for nearly a third of the deaths in the United States in 1900. Now they account for less than one-twentieth of them. Since 1900, the death rate from diphtheria has decreased 99.8 percent and that of bronchitis 95 percent. Between 1938 and 1958 the death rate of all communicable diseases in the United States dropped 75 percent.

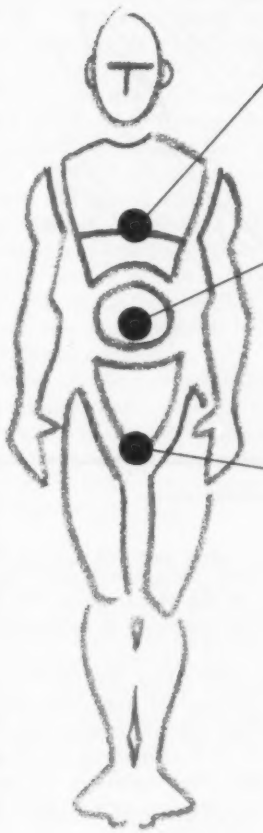
Major Breakthroughs in Medicine. In addition to the sulphonamides and the antibiotics, other highly successful drugs include the steroid hormones and the tranquilizers. The steroid hormones effectively ease pain and restore to useful activity sufferers from eighty specific diseases. This includes arthritis, allergies, ulcerated colitus, tuberculosis, anemia, gout, leprosy and many others. They can also prolong the life of some leukemia sufferers. Tranquilizers have been highly effective in treating mental illness. For instance, the Veterans Administration is now discharging about 41,000 mental patients per year compared to about 28,000 per year before tranquilizer drugs were used.

The rate of discovery of major breakthroughs is constantly accelerating. So, the probability of soon finding preventative means and cures for remaining principal killers is great. Noted medical discoveries were made at the rate of about once each 25 years as recent as 25 years ago. This rate of discovery had increased to one discovery each 10 years by 15 years ago. Now, it seems that one is made every few months.

As you prepare for retirement, whether you are 25 or 60, part of your preparation is to follow the development of disease preventatives and remedies. Use them whenever they are indicated by your doctor. A little knowledge of such things increases your doctor's respect for you, and gives him good reason to use great care in prescribing for you.

A little questioning will soon show whether your doctor is keeping up with the times. This may be a life and death matter to you and your family. However, all of us owe much to the medical profession whose dedicated workers have done so much to make our lives healthier, happier and longer.

WHERE CANCER MOST OFTEN STRIKES



Respiratory System

Age	Percent
65-74	19.0
75-84	9.6
85–	5.7

Digestive Organs and Peritoneum

Age	Percent
65-74	42.2
75-84	42.8
85–	40.0

Genital Organs

Age	Percent
65-74	12.0
75-84	21.9
85–	27.4

All Others

Age	Percent
65-74	26.8
75-84	25.7
85–	26.9

TABLE 4

3. Start Your Plans Now

"Tis said that persons living on annuities are longer lived than others."

Lord Byron

Planning in advance is a common practice that smooths the road ahead. So it is with retirement, where it becomes extremely important. I have asked many intelligent men when they thought they should start preparing to retire. Almost all of them have, without much thought about it, replied, "at about 60 years of age." After some discussion they nearly all agreed it should be much sooner—possibly even in childhood. Certainly it should start as soon as one gets regular employment or goes into business. This is largely because habits have such a strong hold on every one of us. They either make us or break us.

The great psychologist William James once wrote, "Could the young but realize how soon they will become

Fuel for financial success

mere walking bundles of habit, they would give more heed to their conduct while in the plastic stage. We are spinning our fates, good or evil, and never to be undone."

A Beginning. In starting your plans for retirement, decide first the ones that you can do something about immediately and the ones that can be handled best by early decision and action. Start a retirement notebook. Write down in it, systematically, estimates of your future objectives and how you hope to attain them. Do your planning in writing, and revise it now and then as your experience grows and your future becomes clearer.

Have your wife help you—for the realization of such plans will depend almost as much on her as on you. You will need her cooperation and perhaps her prodding from time to time. If she fully understands how often men leave their widows in distressing poverty after accustoming them to generous living, she will be anxious that it never happens to her. She will then become your diligent partner in the effort.

STARTING FINANCIAL PLANS

Where Are You Now. Like a traveler looking at a road map for directions, the first thing to find out is where you are. Then you seek what road you will take to get to your destination. Your road to retirement is a long one. It is not shown on any road map that exists. You will have to scout out the country ahead and make your own map, based on reports of others who have made a similar journey. From them you can learn the things to take with you and the things to discard as interfering with your journey. Most people entering on this journey have little to start with and have to work themselves through it. On the trip they gather where-with-all for whatever life they are going to have at destination retirement.

Now back to finding out and marking on your map where you are. Take that notebook. List in it all of your present assets and liabilities. From these compute your net worth. Then, list your net income for the next year and make a careful estimate of your corresponding expenses. Set down the difference and compute the increase in your net worth that will result from payments to be made during the year. Be sure not to overlook depreciation on your home and automobile and any other physical assets. You may be amazed how little you are improving your finances during the year ahead. Now list the things you might do that you have not been doing—things that would improve your financial outlook. Remember, time and compound interest do wonders in establishing financial security. But you first have to accumulate some chips to enter the game. Now, with the assistance of your wife, make a list of ways to reduce your expenditures. Then add up the savings that will result to see how much you can increase your annual savings.

Security For Your Wife and Family. You will need to provide security for your family should you be disabled or die. How much and what kind of insurance you should have depends on your situation. If your wife is capable of finding a good job in event of your death, and there are no children, little insurance will be needed. Most young workers can't afford enough insurance to protect their families as well as they would if they continued living. You must usually take some chance.

Accumulating Savings. If your employer has a thrift plan for his employes, it will usually be the best way to save. Study the plan carefully before going into it. The big advantage of these plans is that the employer usually contributes considerably to the plan, possibly as much as 50 percent of what you contribute out of your salary. The money is usually turned over to a trust company for investment. Generally, the trust funds are invested in the employer's stock, U.S. Government bonds, or in some combination of the two. The employe usually has the choice of which plan he will use. As a rule, the employe must stay in the plan for some definite period before he can withdraw and retain the benefit of employer contributions. This encourages the employe to stay in the thrift plan, even though at times he might like the money for some other purpose.

The amount of the employe's participation in the thrift plan is usually limited to some percentage of his salary. This percentage increases with years of employment. After 30 or 40 years the combined employer and employe contributions to the plan may amount to an appreciable percentage of the salary. The resulting accumulation, including earnings, received on retiring provide plenty of money for successful retirement.

Usually, the thrift plan and a retirement pension plan go hand in hand. Most retirement pension plans provide for monthly contributions from the employe, the size depending on his salary class and length of service. These funds, together with contributions from the employer, are used to purchase a retirement annuity for the employe from some insurance company. This is an excellent way of saving for your retirement.

The payments you make are deducted from your pay checks. Thus, you learn to think of your funds available for spending as the amount left over after the deduction. This removes the temptation to spend the money on things you can do without.

There are many variations of pension plans and annuities—too many to be treated in detail here. You should study the provisions of any plan your employer offers before you participate. If none is available through your employer, consider buying a deferred annuity from some insurance company.

As you go through life, it is wise, if you possibly can, to have a little nest egg of cash or quickly cashable securities for emergencies. Another good habit to cultivate is to make as much of your money as possible work for you all the time, even if at a low interest rate. Deposits in savings banks and savings-and-loan associations are usually protected by Federal insurance, pay fair interest and can be quickly withdrawn.

Investing For Growth. Early in your business life, buy a few shares of common stock in several large companies, each in a different industry. This way you can learn about various businesses and become an intelligent investor. From investments in bonds, insurance and annuities, you get only the money you invest plus some conservative interest returns.

The money you ultimately receive in return may be of much lower purchasing value than when you invested it. In the past 20 years the purchasing value of a dollar has shrunk about 52 percent, some 20 percent of this being in the past ten years. While this rate of inflation has slowed down to between 2 and 3 percent per year, there is little likelihood that it will cease. Therefore, if you buy securities paying only 3 percent interest over a period of years, your money's purchasing power may be less when you retire than when you started saving. If you spend the interest you are really spending your capital. To offset this inflation, experienced investors try to keep a large part of their investments in real property. Land nearly always increases in value with inflation. Common stocks usually represent such real property and are one of the easiest hedges against inflation to use.

Growth Stocks. The trick is in selecting corporations which will grow and prosper the fastest. You want to avoid those whose earnings may recede. A part of your good money management is to study what makes the economy tick and then use your knowledge and experience to help in your investments.

Unless you are in the business as an expert, do not buy and sell stocks for small margins of profit. Instead, buy stocks of well managed companies that are in some business certain to have a profitable future. The greater a company's diversification, the less apt it is to be hurt by sudden changes in product demand. Frequently, the best information you can get is about the company you work for. If its future is promising and its stock is available at a reasonable price, why look further? An additional advantage of buying such stock is that you will probably know of any unfavorable development sooner than the public and be able to sell before it declines. Also, ownership of such stock should increase your interest in the company and make you a more valuable employe. Owning stock in your company should make your work more interesting. You will have a feeling, if ever so small, that you are working for yourself.

A popular way to invest in stocks, especially for the small investor, is through an investment company or Mutual Fund. There are many of these. They are under Federal regulation—required to make periodic reports to share-holders of all sales and purchases of new securities. They all offer experienced investment management ordinarily available only to wealthy investors. If you decide to invest in a Mutual Fund, be sure you select the one that makes the kind of investments you are interested in. There are many kinds of investment companies.

Some people buy when the market is up—then get discouraged and sell when it goes down. They are not temperamentally fit for investing in common stocks. If you are this way, either reform or leave them alone, because they are bound to go up and down even when the long-range trend is up.

A Business On the Side. Employes in most businesses today work only 40 hours a week and under conditions which ordinarily use little physical energy. In addition, there are six or more holidays and one to four weeks of vacation each year. So, most of these employes have much time that could be devoted to a business on the side. If you are one of these, and can have a side business without interfering with your regular employment, it is wise to do so.

Your Social Security. The closer you are to 65 years of age, the more up to date you should be on provisions of the Federal Old-Age and Survivors Insurance program, initiated in 1936 by the passage of the Social Security Act of 1935. Up to now, June 1961, it has been amended six times, the last time in 1960. It is almost certain to be further amended in 1961. The amendments have broadened the coverage and increased the cost of the insurance to both the employe and his employer. Social Security is basically a retirement program to supply the retired worker with a livelihood for himself and his family. Almost all workers, including most people who work for themselves, are covered by Social Security insurance. It is a combined insurance program, providing life insurance, disability insurance, survivor's benefits and retirement benefits.

At the present time, your employer deducts from your salary 3 percent of your earnings up to $4,800 per year. He adds another 3 percent to make a total of 6 percent which he pays as a tax for your Social Security. You can obtain from the Social Security District Office several free pamphlets containing information on the program. They will help you estimate how much your retirement benefits are apt to be. It is probable that benefits under the program will be increased from time to time, so you will need to keep informed of changes in the law and of the effect they may have on your retirement income. This you will

Learning never stops

need to relate to your over-all plan for retirement funds, which you are keeping account of in your retirement notebook.

At present a man and wife can get up to $190.50 per month. During the fiscal year 1960 the total benefits paid out amounted to $10.798 billion, and at the end of the year there were 14,300,000 receiving benefits. Thus, the average benefit received per person amounted to about $63 per month, somewhat less than the $68.23 average payment toward old-age assistance for approximately the same time.

Before the 1960 amendment to the Social Security Act, little more than 50 percent of the people over 65 in this country were drawing Social Security benefits. Many of them are not covered with it, and many were earning over $100 per month at covered employment. This disqualified them for Social Security benefits until they were 72 years of age, after which there was and still is no limitation on their earnings. The amendments of 1960 provided a new program of medical assistance to the aged. This is to be administered by the states, with the Federal Government making grants to help cover the cost.

4. Continue Your Retirement Plans

"Nothing is impossible to the man who can will."
Mirabeau

MENTAL PREPARATION

To the financial preparation discussed in the previous part, you should add a self-planned program for systematic self discovery. Create interests which give you a sense of both growth and pleasure. This way you can face the future knowing you will always have something worthwhile and pleasureable that you are able to do. You can thus avoid the feeling of being "shouldered aside," "a has been."

Progress or Regress. Psychologists agree that you have your choice to learn or not to learn when you are young. But if you do not continue to learn as you grow older, soon it will become almost impossible for you. Some people continue to learn much longer than others. I heard a scientist explain this by comparing people with plastics; some are thermosetting others thermoplastic. The thermosetting ones can be molded only once, while the thermoplastic ones can be molded over and over, some an unlimited number of times. Most people are like the thermosetting plastics. They can be molded only once, and upon maturity they are thereafter unchangeable. Other people are like the thermoplastics. They can be molded over and over by their environment.

There seems to be no sharp dividing line between these two classes of people. Those who resemble the thermosetting plastics can keep from setting into one form by continual study and mental improvement. That is why it is so necessary for each of us to make new friends and continually try new things and new ideas all our lives. By diligent effort, we can thus go all the way through our lives, happily adapting ourselves to whatever we encounter.

Early Talents Last Longest. Do not for a moment think you can keep living long after 60 or 65 unless you continue work of some sort. You must work to stay alive. That which is not used dies. Your present work may be such that you can continue it part-time for the rest of your life, but this is unlikely. Most of our lifetime occupations are largely the result of accident. They don't always coincide with our best natural talents, especially ones that could be used after retirement.

There is a well known psychological principle that one's early talents last the longest. Borrowed talents, acquired by practice in business or profession after maturity, we lose first. So each of us, as early in adulthood as possible, should analyze our childhood talents and preferences. What did you like best to do as a child that you could still do after you retire? That is the question. Don't depend on your own recollection alone. You may have forgotten something important. Talk to the friends of your youth, your parents and teachers.

Your Philosophy of Life. Part of your mental preparation for retirement is the development of the right philosophy of life. There are many questions you can ask

yourself to see if you're heading in the right direction. A few of these follow:

- Am I confusing making a living with living?
- What are my most important objectives in life?
- Could I live contentedly with small means, and how could I manage to do so?
- How important to me is luxury?
- Which is more important to me, worthiness or riches?
- Do I meditate on why I am living and what I really want?
- Where am I heading and is it where I really want to go?
- Have I found life precious, and if not, why not?
- Do I live principally for myself?
- Is my purpose in life permanent and important?
- Do I laugh off unimportant annoyances and do I ever laugh at myself?
- Do I use a sense of humor as a shield against tensions?
- How important to me are life, liberty and the pursuit of happiness?
- Am I deeply interested in my influence on others?
- Am I using my leisure to improve myself or to help others, or do I enjoy idleness for itself?
- Am I always cheerful and if not, why not?
- Am I overeager about myself?
- Do I look to old people for wisdom?
- Do I have an unselfish purpose in life?
- What would I do if I had $1 million, and what does this tell me about myself?
- Am I allowing my work to absorb all my interest; am I its slave or is it just a means to an end?
- Do I constantly practice serenity and refuse to be upset by anything?
- Do I love power, and if so what is it doing to me?
- Do I enjoy changes and do I adapt myself to them easily?
- Do I have tolerance and patience when dealing with others?
- Do my friends commonly confide in me?
- How necessary to me are the companionships of fellow workers?

These questions and any others dealing with your philosophy of life, together with your answers, could be put into your retirement notebook. Then they should be meditated upon to the end that you know yourself well. Decide how you wish to change yourself and get busy doing it. The sooner you establish your standard of becoming and being and mold your habits to fit it, the better you will be prepared for your retirement.

OBTAINING AND RETAINING PHYSICAL HEALTH

Eat Your Way To Health. The Germans have a saying that "one is what one eats." One of the most important things in life should be what we eat. Food and health are closely allied, even in relationship to specific diseases. For instance, animal fats are thought by many doctors to contribute to arterial disease. It's true that many diseases are more prevalent and more serious among the obese, and obesity is mostly due to improper diet. Some people have allergies to certain foods, and to them these foods are virtually poisons.

There are three well known classes of foods: proteins, carbohydrates and fats. Minerals and vitamins are also needed in the diet. Normally, you should be sure to get plenty of proteins in your food. They are body rebuilding foods. They are split up in our digestive system into material which builds about 50 billion new body cells each day to replace those constantly broken down in the process of living.

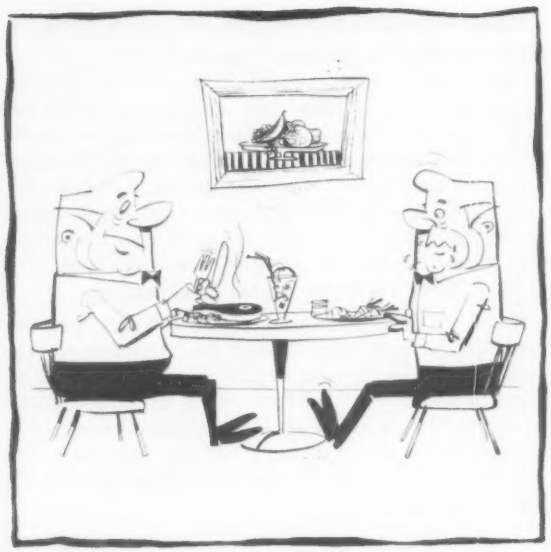
Meat is the principal source of protein among most people in this country, and is generally believed to be better than proteins from other sources. However, we can thrive on proteins from milk, beans, nuts and vegetables. To those who can afford it, eating a great deal of lean meat is the most pleasant way of keeping down or reducing one's weight.

Carbohydrates are necessary to health, but because they are energy foods they add weight more so than proteins. Those who are underweight or do heavy physical work may use them generously. They are obtained in combination with proteins in cereals—generally the most economical foods we can find.

Fats are concentrated energy foods. They contribute much to the pleasant taste of foods. Rich food is high in fat and overweight people nearly always eat more fats than they should. There is a strong suspicion that animal fats, which are solid at body temperature, contribute to diseases of the blood vessels. They collect on the inside walls of the blood vessels and restrict the flow of blood. Many middle-aged and elderly people carefully avoid all but the unhydrogenated vegetable fats. These are liquid at body temperature.

While it is not certain that animal fats are dangerous, there seems little reason to use them when vegetable fats are available at lower cost. The idea of fats contributing to heart disease is not new. Fifty years ago there was much talk about fat people dying of "fatty degeneration of the heart."

As a general rule, it is wise to plan your diet around a wide variety of foods using meat, milk, eggs, poultry, fish, vegetables, fruits, cereals and bread. The specific foods and the amounts of each that you should consume depend on your own situation, i.e., age, physical activity, financial ability, size and likes. Make a habit of studying the relationship of foods to health. Then apply this knowledge to selecting the food you consume. One of the best sources of reliable information is the U. S. Department of Agriculture. Its various food-guide bulletins give authentic information for all ages and types of individuals. They can help you obtain proper nutrition and keep down the cost of your food.



Don't dig your grave with your teeth

Keep Your Weight Below Average. An important part of eating properly is the regulation of the quantity and the kind of food eaten, in order to maintain proper weight. Every person should determine his best normal weight and carefully maintain it. The sudden gaining and losing of weight is not good for you. It puts a strain on body metabolism. Recently, the Metropolitan Life Insurance Co.'s tables of desirable weights have been lowered from five to eight pounds in each category. These are based on the latest life expectancy figures, which show that a 45-year-old man of medium build who is 5 feet 8 inches tall and weighs 150 pounds should live about four years longer than a comparable man weighing 200 pounds, and 18 months longer than one weighing 170 pounds.

It pays to stay slim, because generally fat people die sooner than slim ones. Slim people are likely to have lower blood pressure, and low blood pressure means a longer than average life. The death rate among men weighing 20 pounds more than average is about 10 percent above average. When their weight increases to 25 pounds above average their death rate goes up to about 25 percent above average. And, for men weighing 50 pounds above average the death rate increases to about 75 percent above average.

The ideal weight for the average-sized man seems to be about 20 pounds below normal average. Check your weight. The chances are that you need to reduce, but don't reduce rapidly. You can reduce safely by choosing your food carefully, greatly reducing your intake of fats, sugars and starches while being sure to eat plenty of protective foods.

The popular 900-calorie liquid dietetics are also valuable in weight loss and control when used with discretion and your doctor's recommendation. A thorough discussion of the pros and cons of liquid dietetics appears in the May 1961 issue of the *Reader's Digest*.

Exercise for Health and Pleasure. Almost as important for health as the food you eat is the exercise you take. The amount, type and time of the exercise that is right varies with the individual. Many people, particularly housewives, get about all the exercise they need in their work.

The things to stress in exercising are regularity and suitability. Some people try to do a week's exercise in one afternoon. This does more damage than good and frequently sends middle-aged people to hospitals or an early death. But most doctors agree that regular exercise is vital to health at all ages. Some fear that the future of the country is being threatened by creeping sedentarism. A doctor recently told me that both heart disease and ulcers are now considered sedentary diseases. Fat tummies and fat heads have a tendency to go together. One has both if he refuses to control food consumption and exercise sufficiently.

How Healthful Is Exercise. The idea of exercising for health is not new to you. Nothing is so widely believed in and so little practiced as exercise. It is difficult to schedule regular exercises. It takes a lot of determination to do sitting-up exercises every morning or evening—too much for practically everyone.

Healthful play is undoubtedly the best way to exercise, but it is sometimes dangerous for those no longer young, when it gets too competitive. Make it an inviolate rule to quit the game whenever it gets too competitive for your age and physical condition or whenever you become tired. Nature gives us warning when we are overdoing. She is your friend—give heed to her. There is real joy in keeping in training all your life. In the long run you will probably be more successful in your business or professional life if you take time out every day to enjoy physical play of some kind.

If your work and other duties make it impossible for you to schedule regular exercise periods, devise some exercise for which you can find the time. It is surprising how much exercise you can get in taking a bath and rubbing yourself with a towel, and in dressing. Try walking all or part of your way to and from work. If this is the only exercise you get, you should walk briskly not less than two miles every day. As you grow older, divide your exercise into two or more periods with good rests between.

Exercise stimulates the circulation by increasing activity of the heart and lungs, and by its effect on the blood vessels. Every time a muscle tenses it squeezes out the blood in the vessels in that muscle. When it relaxes the blood rushes back in. So exercise flushes out the blood vessels and prevents blood from stagnating in them. Some doctors claim that when blood stands still poisons develop, and that these poisons may cause us to age faster. While this may not be scientifically proved, indications are strong that it is so.

Exercise also helps to keep the mind alert. When you feel dull and listless and your mind refuses to think clearly, go out for a brisk walk or play some active game in the open air. Then notice how clearly you can think.

5. Old Age—Everyone's Problem

"In old age we live under the shadow of death, which like the sword of Damocles, may descend at any moment, but we have so long found life to be an affair of being rather frightened than hurt that we may become like the people of Vesuvius, and chance it without much misgiving."

Samuel Butler

EFFECT OF THE AGED ON SOCIETY

The Financial Burden. There are, as of April 1961, approximately 17 million persons over 65 years of age in the United States. People are reaching age 65 at the rate of about 3,000 per day or almost 1,100,000 per year, and this rate is increasing at about 3 percent per year. At present a little over 9 percent of the population is 65 years of age or older. By 1970 it is estimated that more than 11 percent, or over 22,000,000 people will be 65 years of age or older. In the next ten years some 12 million people will reach age 65, while about 6 million are expected to die. If major breakthroughs in the treatment of the remaining principal killers of the aged (heart disease and cancer) occur, most of these 6 million people may not die. Thus, the number of people over 65 years of age in this country could easily explode to around 25 million or one-eighth of the total population.

In the past nine years the cost of the Social-Security old-age insurance program has increased from about $1.5 billion per year to $11.6 billion per year. In the past two years this cost has increased over 41 percent. If this rate of increase continues, the cost of the program in 1970 will be about $24 billion. This is not an unrealistic estimate—it is a possibility that must be taken into account.

At the end of fiscal year 1960, almost 14.3 million persons were receiving benefits from the Old-Age and Survivors Insurance. A small proportion of these were wives, widows and children, under 65 years of age.

The sixth amendment to the Social Security Act was signed by President Eisenhower Sept. 13, 1960. It made many changes. Under it, a beneficiary who earns over $1,200 in a year will get more. Only $1 in benefits will be withheld for every $2 of earnings between $1,200 and $1,500, and $1 in benefits for every $1 in earnings above $1,500. As before, after age 72 the worker gets the full amount of benefits regardless of earnings.

These 1960 amendments also provide a new program of medical assistance to the aged. Federal grants become available to states which start medical assistance programs for all residents 65 and over who do not receive old-age assistance, but are unable to meet medical expenses. The new administration does not feel that this medical assistance provision is adequate. It wishes to begin a program of hospital care, nursing, and other care for all persons over 65 entitled to Social-Security or railroad-retirement benefits under the Social-Security program. It is proposed that the cost of this program be financed by raising Social-Security taxes by ¼ percent for both employe and employer, and that the total cost will be about $1.5 billion yearly. Social-Security taxes, now 3 percent of the first $4,800 earned, for both employe and employer, are scheduled to advance to 3½ percent in 1963, to 4 percent in 1966 and 4½ percent in 1969.

In addition to the cost of the Social-Security benefits for the aged, as of July 1, 1960, there were 2,354,992 recipients of old-age assistance under state programs. The Federal Government's share amounted to over $160 million per month. The aged are a tremendous financial burden on society. Still, the benefits from Social Security, together with other income, are insufficient to provide a decent standard of living for the aged. About 60 percent of those over 65 have less than $1,000 per year total income. Only one out of five has more than $2,000 per year. The average total income of all persons over 65 years of age is less than $1,900 per year. Aged widows benefits awarded in March 1959 averaged only $61 a month. At least four out of five persons in this country over 65 years of age are existing on far less than what are considered the basic necessities of life.

Mental Hospitals. It is a custom, when old people are unable to look after themselves and have no relatives to look after them, to send them to State Mental Hospitals. There they stay until they pass away. In Oklahoma, one-third of the admissions are such old people, a condition that is probably true in most states. For many there is no other place to go. This is probably the reason that more hospital beds are occupied by mental cases than by all others combined. If the mental hospitals dismiss 50 percent of their cases within a year or two, unless the elderly patients die off faster than the others, they would occupy a large proportion of the beds in a few years. In mental hospitals, the cost of testing and treating a patient during the first few months is high—over $4,000 in many hospitals. This is an expensive way for society to take care of the aged. And, what a humiliation it must be to those who are mentally competent.

PROBLEMS AFTER SIXTY-FIVE

The Great Day Comes. Finally the great day comes when they ceremoniously give you your first pension check, some kind of parting gift, words of appreciation for your past performance, and wishes for your happy retirement. Then, you are kindly kicked out the front door and are on your own in what may seem a strange world. True, you have been invited to return for visits as often as you please. But then you begin to think about

how you are going to miss the office camaraderie, and you know that it would be imposing on the company to return for frequent visits.

If you have not planned in advance, you have no purpose in life. And, having lived for a purpose, even though no more than to do your daily schedule of work, you feel lost without something you must do. The fleeting idea passes through your mind that your fellow workers envy you. Then you reflect that it is not you and your age that they envy, but the freedom that is yours. Ah! that is it—freedom. It must be great! Yes, but for what? Now you are getting down to realities.

Now, you tell yourself, "I am going home and before I do anything in particular about my future, I will get the Mrs. and we will take a trip in the car. We will go as we please this time, and visit all our children and perhaps even the old home town." Or, perhaps it is a trip around the World, something you never before felt you could spare the money or time for.

Work After Retirement. You now come back from that trip after retirement, whatever kind it may have been, raring to do something. As Robert Browning once wrote:

"When a man's busy, why leisure
Strikes him as wonderful pleasure;
'Faith, and at leisure once is he,
Straightway he wants to be busy."

Now is when your planning for retirement stands you in good stead, because you should have given years of thought to what you are going to do. If you cannot go back to part-time work, perhaps you can be a consultant or special representative for your former company. If you have to work because your income is too low to live on, you have missed the boat in not getting completely ready for retirement. Only about one in five persons over 65 have paying jobs. However, about 37 percent of the men have such jobs while only about 10 percent of the women have them. You will probably have to work for less than you are used to, and you may have to move to some other location to get work at all.

Heed the advice so nicely offered by Kenyon Cox:

"Work thou for pleasure—
Paint, or sing, or carve
The thing thou loves, though the body starves—
Who works for glory misses oft the goal;
Who works for money coins his very soul.
Work for the work's sake, then, and it may be
That these things shall be added unto thee."

The prospects of your being able to retain your present job or obtain one, according to the National Association of Manufacturers, will be improved during the next ten years. NAM predicts ten million new job holders will be needed during this time. Because of the low baby crops of the depression years, there will be a shortage of people between the ages of 25 and 44 to fill these jobs. So, about two million of them will have to be filled by men and women now past the customary retirement age.

But automation and the construction of more efficient production units may reverse this trend and actually reduce the number of workers needed. This employment situation would be greatly aggravated should we have substantial disarmament. However, there should be a greatly increased demand for engineers, teachers, scientists, mathematicians and highly trained technicians.

Your Home. Where and how you live in retirement or while working at some new job is important. Most retirees stay in the locality, and usually in the home they own when they retire. Some stay on to be close to their friends or children. But children get other interests and usually pay little attention to their parents, although attention from grandchildren can be very gratifying.

Your social life is usually tied in with your job at the office before retirement and largely goes with it. You then feel neglected. Your house is probably too big for the two of you to live in comfortably. It requires too much care and upkeep, and may remind you too much of the past. One of your first jobs, if you like to work with your hands, may be to redecorate it and put it into condition to sell. No one can tell you in detail what to do because what is right for one retiree isn't right for another. This is a decision you must make before you retire.

Illness. About the worst thing that can happen to you in retirement is a long siege of illness. While hospital care is better than it has ever been, its cost is increasing at the rate of about 5 percent per year. Only about 40 percent of the aged have any hospital or surgical insurance. With three out of five having incomes less than $1,000 per year, only one out of five between $1,000 and $2,000 per year, and only one out of five having incomes greater than $2,000 per year, only about 20 percent of the aged can afford good medical care. Most elderly people are forced by lack of money to forego physical checkups by which diseases are discovered in time to do something.

It is fortunate that so many companies let their retirees keep their group health insurance. Some even let them use company medical facilities, particularly for periodic physical checkups. At least one insurance company now offers persons over 65 coverage of hospital room and board, lab fees and surgery for a premium of only $6.50 a month.

The body mirrors the condition of the mind. The lack of financial, physical and mental preparedness for retirements leads to disturbed minds reflected in body ills. In New York City, when day centers for the aged were established in certain localities, and the aged found things of interest there, including companionship and recognition, the number that went to clinics decreased 70 percent. They were diverted from thinking about themselves and reviewing their fears. Some fears or injurious attitudes of the aged are:

- Fear of old age
- Fear of sickness and invalidism
- Fear of poverty
- Fear of losing social prestige
- Fear of having to take a back seat

- Fear of the future
- Fear of loss of vigor
- Fear of losing liberty
- Fear of death.

Loneliness. Loneliness and the feeling of not belonging are almost identical. When you have one you have the other. One geriatrics doctor lamented the fact that so far no one had devised an antibiotic for loneliness and rejection. Those who live their retirement years with a mate avoid much of this problem. However, sooner or later, it reaches almost every one of us. Calculating from the tables of chances for survival of white men and women at various ages, there should be about 21 percent more white women than men at age 65, 32 percent more at age 70, 47 percent more at age 75, 67 percent more at age 80 and 92½ percent more at age 85. At age 70 more than half the women are widows, while only about 25 percent of the men are widowers.

Recently, I visited a very old friend who at 96 looks like he is about 65. He had aged appreciably since I had seen him a year or so earlier. He told me there was nothing wrong with him except that he could not focus his eyes at either close or far objects, and that he was lonely. I told him it looked like he was going to live to more than 100. He replied that he was *afraid* he might. At my expressed surprise that he should be afraid he might live that long he said: "You know, we used to invite people down to have dinner and play bridge with us. But things are done by couples, and since my wife died last year I am sort of stranded."

He also said that practically all his friends were dead and his children and relatives live at distant places. Though this man is in physical condition to live many years, he wants to die and will probably do so soon. He was well prepared to retire except for a few things. He had not learned early in life to be largely self-sufficient. He did not take sufficient interest in creative things he could do by himself, and he overlooked the making of a lot of new friends much younger than himself. However, he did have 30 good years after 65, although he only partly retired for many of them. Had he continued to carry on the business he was in, on say a 10 percent part-time basis, he would have had the contacts with other people so sorely needed.

6. Your Life After 65

"Intelligence, and reflection, and judgment, reside in old men, and if there had been none of them, no states could exist at all."

Cicero

How lucky we are to have been born. It took some additional luck to have lived through two world wars and one police action, a plague of influenza, serious depressions and the hazards of the modern automobile. Surely this luck is going to continue with us a little while longer, and we will continue to live—but live for what? Not for ourselves alone if we are going to be happy. Your luck after 65 is largely the result of preparation you have made for this period of your life. The habits of thought and action you have developed now stand you in good stead—staffs to lean on. You must now stand firmly, chest up, back straight, chin in and look the whole world in the face—still attempting, still expecting and still accomplishing something for the benefit of yourself and humanity.

ACCOMPLISHMENT

What Others Have Done. The best proof that you can do something is that many others have done it. The World is full of both great and little accomplishments. We hear little about the little ones and much about the great ones. So we tend to overlook the fact that the little accomplishments of men may, as a whole, be more important than the great accomplishments. However, great accomplishments are frequently cited by inspirational writers to stir their readers to greater endeavor.

Certainly accomplishment need not stop at age 65. It is probable that a study of when people accomplish the most would show that people over 65 achieve as much as during any other equal period in their lives. Many great men did their finest work late in life. If this was possible for them, it probably is for you.

However, we do not all have equal natural durability. Some are born to live longer than others. Natural abilities and talents usually bear fruit in elderly people when they are cultivated consistently from youth.

For example, take a look at Justice Oliver Wendell Holmes, who was active on the Supreme Court until he was over 90 years of age, and died at age 94; Grandma Moses started her career as a great painter at age 78, teaching herself by experimentation, and is still painting although she was 100 years old last September; Winston Churchill bore the brunt of leading the United Kingdom through the second World War when he was almost 70, and is still active in the British Parliament at the age of 86; Bernard Baruch's opinions are still coveted by political and business leaders although he is 90 years of age; the artists Michelangelo, Titian, Goya or Verdi all were still painting masterpieces in their eighties, and Titian painted his masterpiece at the age of 99. You can learn from them that such things are possible, and that you may be able to do your best work long after your normal retirement age of 65.

Why You Should Accomplish. People in the act of accomplishment are nearly always happy. So for your own happiness you should try to accomplish something worthwhile all your life. A sense of contentment follows accomplishment—so much so that many people have found they are not happy at playing games such as golf unless they have first accomplished something.

We must earn our right to play before our inner consciousness permits us to recreate in peace. Entertainment in itself is not a satisfactory goal for any person, although it is fine after a day's work is done. Confucius, who taught one-fifth of the World to live together as brothers without war once said, "I am one who in pursuit of knowledge forgot his sorrows and did not feel that old age was coming on."

For most people life is work. Without it they are lost for they cannot adjust to doing nothing but play, read and rest. Dr. Edward L. Bortz, a former president of the American Medical Association, who specializes in the diseases of the aged, feels that no able-bodied person should retire until he is at least 90. He believes that, in the 30 years between 60 and 90, a person really comes into his own. He says, "There is a strict biological law which says that a part of the body that is not used dries up. This applies to the mind too. Work in moderation is the best way to increase health and longevity."

What Employers Can Do. The question of whether people are being retired too early is receiving increased attention in newspapers and magazines, and by people interested in the problems of the aged, many of which would be solved by continued employment. Many of the nation's doctors have joined the outcry against this useless waste of mental and manual skill and experience. Economists sometimes designate it as the growing dilemma of our time. Too many people are being kept by too few.

With the rapid increase in the number of retirees compared with employed workers, we have a problem which threatens to grow worse year by year. How are we going to support so many idle people over 65? In a few years, if we stick with the forced retirement age of 65, the number of retirees over 65 may amount to over half the number of employed workers. That means that each working person will, on the average, be furnishing one-half the support of another person besides providing for his own family.

In another ten years, unless a change is made in retirement policies, Social Security deductions will probably increase to at least 5 per cent for both employe and employer making a total of at least 10 percent of the employe's salary up to $4,800 per year. While the economic problem is important it is not the whole problem. According to the U.S. Department of Health, Education and Welfare, only about one in 25 retired persons retire willingly. Social workers in day centers for older people, golden age clubs, mental hospitals, and elsewhere try to keep the ones who come under their ministrations busy at some creative work. But these old people know the difference between "made work" and "real work." They want to really work at something that brings them recognition and a feeling of achievement and of belonging. Anything else is makeshift, and should be beneath the dignity of mankind to foist off on their elderly people.

Because of economic, moral and national-interest reasons, compulsory retirement at any arbitrary age seems ridiculous. It has probably always been a lazy way of dealing with a difficult problem. It has become mostly a matter of custom. It is easier to do as others have done than it is to think the problem out for yourself.

No doubt, the practice started because of the generally accepted viewpoint that work is unpleasant and leisure wonderful, and that when a person has worked until he is 65 he deserves his reward of freedom from work. The trouble is, few workers are ready for this reward and do not know how to go about providing their own worthwhile activities.

Also, with company group insurance and retirement pension plans, it became almost necessary to have certain cut-off ages for all employes. With more enlightenment on retirement problems and with the public and the employer's interests so deeply affected by the retirement of capable workers, many wide-awake companies have already reviewed their retirement policies. Plans have been altered to conform to modern realities, providing retirement for those who should retire and for reduced work load, shorter hours and lower-pressure jobs for others.

LONGEVITY

Learn From Those Who Have Lived Long. What about man's life span? How long is it? What can you do to reach your natural life span? Certainly, you would like to know the answers to these questions. No one can definitely give them to you, but there are good ideas and probabilities concerning them that are worth considering. Those who discuss how long man was intended to live usually cite the fact that in the higher orders of animal life, except man, the life span is from six to seven times the time it takes for the animal to reach full growth. Since man reaches full growth at about 20, his normal life span should be in the neighborhood of 120 to 140 years. We could well say that the diseases that kill people are just accidents which make our life expectancy so much shorter than our normal life span. Nearly always, the persons who die in their 70's are well preserved physically and intellectually and their deaths are rarely due to senile disability. They died from accidental causes, not from the gradual exhaustion of their vital forces.

Don't be discouraged if your immediate ancestors did not live to a fairly old age. They may have been killed off before their natural time, and modern medicine and health practices may be all you need to attain a very old age while enjoying the living that goes with it.

In studying the lives and habits of the old people I have known or read about, the following seem to be common to most of them:

- They came from families where old age frequently occurred
- They worked practically all their lives
- They were religious and usually accredited their long lives to the grace of God
- They were frugal eaters of plain foods and were mostly below normal weight

- Many had some affliction such as a sensitive stomach which they had to favor by eating lightly of easily digested foods
- They were active both mentally and physically, especially physically, and particularly liked regular walks for exercise
- They were determined to keep on living
- They were serene so that little tension occurred in their lives
- Most of them slept regularly and well
- They were deeply interested in the people about them and in the events of the times
- Most of them were poor. This may have been due to the wealthier people working themselves to death or digging their graves with their teeth.

What You May Expect in the Future. Today, we have in this country many successful and wealthy old people, many of whom may live to extreme old age. This will probably be due to the recent great advances in medical care and knowledge of how to live healthfully. It takes time to evaluate the effect of modern geriatric care of the aged and the knowledge of how to live longer. But I feel certain that in another 50 years we will have many healthy and active people well over 100 years of age who will be contributing greatly to the social and economic improvement of our world.

RETIREMENT ACTIVITIES

If your work is such that it is not advisable or possible for you to carry on with it after retirement and there seems no real work that you care for, then you will need to substitute activities. This will keep time from hanging heavily on your hands and keep you mentally and physically alert. There are many such activities for retirees, but the best ones depend on the individual's situation and preferences. Some of these activities are worth discussing in a general way.

Play. As children do, take play seriously. Adults are apt to forget how to play. Play at any age can be both enjoyable and useful. From your store of experience and knowledge, you are equipped to play seriously—to find satisfaction and enjoyment in things you do just for fun. If possible, keep your friendships by playing with your friends, and make new and younger friends through play. However, do not play too strenuously for your physical condition. Get your allotted amount of exercise through play if you can arrange it that way.

Hobbies. My dictionary says a hobby is a favorite interest aside from one's business. One's business may be of greater interest to him than any hobby. It may be so great that he needs no hobby at all, providing the business activities are varied and provide exercise in the open air, relaxation and fun. Most of the writers about retirement and old age put a great deal of emphasis on hobbies, claiming that everyone should have a hobby. Long before retirement age, every person should deliberately search out at least one hobby that he could practice after retirement.

It is usually more interesting to work with other people having the same hobby than to work by yourself. Golden age clubs and day centers for the aged usually provide facilities for the practice of hobbies as well as encouragement and assistance when needed.

Travel. We are all adventurers in spirit. Retirement provides the chance to experience some of this adventurous life we hanker for. Travel is often disappointing. Socrates said, "See one promontory, one mountain, one sea, one river, and see all." Cervantes advised, "Journey over all the universe with a map, without the expense and fatigue of traveling, without suffering the inconveniences of heat, cold, hunger and thirst." One kind of travel which all of us can do is by means of the imagination. By it we can say with Richard Burton,

"I sit in mine house at ease,
Moving nor foot nor hand;
Yet sail through uncharted seas
And wander from land to land."

Most travelers agree that the pleasure of travel exists mostly in retrospect and seldom while being experienced. Planning the trip and telling friends about it afterwards are frequently the rewards of traveling. Whatever the trip you take, plan it carefully in advance; know about the places where you are going and what you expect to see.

Reading and Thinking. Yes, reading and thinking go together. Reading without thinking is nothing at all. Those who read this are sure to be thinkers as well as people with a purpose. Mature people read more to obtain information and ideas than for pleasure alone. Both types of reading are advisable. Great writers are artists, and the beauty of the writing may be its greatest characteristic. Such writings please our ascetic feelings and give us spiritual uplift.

If a person has a purpose for learning or an interest in the subject, learning can always go on. Dr. Wilma T. Donahue of the Division of Gerontology, University of Michigan, who has studied the effect of age on mental capability, says that persons of 70 are as capable mentally as they were at 50. At 80 the intellect is often equivalent to what it was in one's 20's and at 90 the mental return is frequently back in the teens. There are many other similar statements by experts which could be cited to support the conclusion that age is no barrier to thinking and learning.

Before and after you retire, take much time for thinking, particularly about your own problems. You are more apt to really think about your own problems than about others. To think, you solve a problem in your mind by clear recall, comparison, inference, imagination and logic. Be sure your thinking is systematic. Too many people think that holding an opinion is proof of thinking. It may be simply copying. It is an old American custom to copy after successful people. This is good and effective in many ways, but it should not be carried too far.

You need to analyze your own thinking to see if it is original or just someone else's opinion which you have adopted without thinking. Learn what others are thinking and why they have formed certain opinions. Then think the matter through and decide for yourself. Some-

times your thinking will cause you to adopt the opinions of others, because you have checked into the education and experience of parties holding the opinions and found them qualified to reach the correct opinion while you are not.

The effect of mental activity on longevity has been investigated to some extent. Investigations of about 300 great men having intellectual interests, consisting of scientists, writers, statesmen, musicians and philosophers, disclosed that nearly 15 times as many of them lived into the eighties or older than was average for the population. Their attainments may have been partly due to the longer time they had to develop their abilities and talents. Also, intellectual activity is so much easier to maintain than physical activity in old age.

Creative Activities. Such creative activities as painting, sculpturing, musical composition, inventing, and writing are highly rewarding for retired persons. You may find you have a talent or talents which you never suspected that will contribute to years of happiness and contentment.

7. Your Utopia

"Mid pleasures and palaces, though we may roam, be it ever so humble, there's no place like home."

John Howard Payne

According to the survey of the Senate Subcommittee on the Problems of the Aged and Aging, three out of four of all aged people live with some family member, 15 percent in their own homes alone or with relatives, 4 percent with non-relatives (but not in their own homes) and about 6 percent in institutions, hotels and rooming houses. Also, most old people live in the state where they were born, and almost all of them in urban areas. These locations of the homes of the old people are not necessarily as they should be, but most old people have little choice in the matter. This chapter is written for those who plan to have a choice in the matter by preparing for retirement, and for those who have established a position where they are able to choose.

WHERE DO YOU WANT TO LIVE?

Your Choice of Living Conditions. If you are like most retirees, you do not want to live with your children. It nearly always creates unhappiness for all concerned.

If you plan to establish a new home, you will want to live within walking distance or easy transportation distance of shopping facilities, your church, the post office, a library, and recreational facilities. Usually, you will not want to live with too many old people. Most people seem to prefer living in the house where they lived before retirement. Most wish to live in a neighborhood where they have old friends.

Why Move? Frequently, when starting a new life after retirement, a complete break with the past is advisable. The house you live in may be too large. It also holds too many reminders of the past. To live long and to be happy one must live for the present and future.

Upon retirement, your income is usually sharply reduced, so keeping up with your previous social group may become impossible. Old friends have a habit of dying off one by one, and at home you will be faced with the sad necessity of attending many funerals and sharing in the grief of those left behind.

You may wish to stay near your children and grandchildren and frequently this is wise. To your grandchildren you may be great, and this gives you the feeling of importance you need for happiness. It has been said that in old age do not put too great a store in your sons, for when they marry you lose them. But you have your daughters all your life. However, in your home town you may be little more than a convenient baby-sitter for your children.

As contrasted with staying put, you now have a chance to move to a new place which may give new excitement to your life. You may also find a climate far more satisfactory for older people. Good climate is a desirable factor in choosing your retirement home. In parts of this country where the winters are severe, about four times as many deaths occur among the elderly from heart and associate diseases in the winter months than in the summer months.

Deciding where to live is a very personal matter. No one can tell you where you will find the greatest happiness. It is something you must work out for yourself. It deserves a great deal of attention and study, perhaps some actual trial. After you have picked out your anticipated Utopia, it is usually wise to rent your home furnished for a year. Then move into rented quarters in the community where you wish to live. This way you can test your selection and still be able to return home without too great a financial loss. The usual feeling in retirement is similar to that before retirement, that no matter where you are the best place is somewhere else.

Factors you should consider when picking the location where you will live in retirement follow:

- Availability of hospital and medical care
- Fitness of the community for your individual needs and finances
- Good recreation and social activities
- Availability of employment if needed
- A suitable church
- Distance from home, relatives, and friends in the

event you should ever wish to visit them or have them visit you
- Adequate transportation to places you wish to go
- The tax situation, i.e. sales, ad valorem and income taxes and homestead exemption on tax on home
- Availability and cost of foods you want, and their cost
- Availability and cost of suitable home
- Correct climate for you
- Suitability for the practice of your favorite hobbies.

California. There is a saying that no one living in California ever retires to any other state. There has always been romance and adventure connected with the very name of California. People from all walks of life and of ever nationality and type have been moving out there in great numbers since early in this century. According to the 1960 census, California surpassed all other states in population growth since the 1950 census. The 5,100-000 gain accounts for nearly one-fifth of the increase for the United States.

During the past 20 years, California has become highly industrialized. There is wealth and creative activity everywhere. While it is a mecca for tourists and retirees, there are so many young people who have moved there that the percentage of old people in the population is about the same as for the whole country. There are all kinds of opportunities for retirees of all kinds to find work in California. Usually, there is work suitable for them and near nice residential communities.

One could truly say that California has every type of weather, community, occupation and recreation that a retiree could possibly be interested in. All you have to do is investigate until you find what you want. It is not a heaven-on-earth as migrants I used to encounter seemed to think, but somewhere within it you can certainly find your retirement Utopia.

Florida. Florida is second only to California as a Utopia for retirees. It does not have the big varieties of climate, scenery, industrial development, or natural resources that California has. There are not nearly as many opportunities for the retiree to work as in California. However, Florida does offer great inducements to retirees.

The proportion of old people moving to Florida is much higher than any other place. The percentage of older people in the population is probably higher than in any other state. Percentagewise, Florida's growth in population between the 1950 and 1960 census, was the greatest of the states, 78.7 percent compared to 48.5 for California. Its population is growing at the rate of about 250,000 per year. Real estate developers are busy building up new communities with homes to sell to retirees. These are advertised heavily in newspapers, on television and radio, and by solicitations through the mail, all over the north. Some firms even have sales booths at major air terminals and railroad stations. They have agents in most large cities. People approaching retirement age are offered "Florida living," sunny beaches, small-boat harbors and even country clubs with their home site, for a small down payment and a few dollars per month. Such sales are even made by mail order. In 1958 the mail-order sales amounted to about 45,000. It is said that retired people will just have to come to Florida because it is the only place where you can retire on an income of $200 to $300 per month.

Florida does not have a State Income Tax. Personal and property taxes are low and farm homesteads up to 160 acres, and city dwellings on lots of half an acre or smaller, are allowed "Homestead Exemption" up to $5,000. Even with a fairly costly house, you have little tax to pay since valuations are only about 50% to 75% of the actual cost. Also, houses are considerably cheaper to build in Florida than in states farther north.

Yes, you may get too much rain at times and there will be bugs you will need to fight. In some areas there may be snakes, but you can keep away from swampy areas and avoid them. There will be tourists galore during the winter months in some areas. And, since they spend more money than residents, they will get the first attention. There are many ways of making money off tourists which may be advantageous if you need extra income.

Do not judge Florida by the Gold Coast where rich people go in for high living. It is only a small part of Florida—a narrow strip about 75 miles long between Palm Beach and Miama. Florida's coastline is over 1,100 miles long. There is very little of Florida that is over 75 miles from some coast, and the average of the land area is probably not over 25 miles from the coast. Wherever you are, it is only a short drive to the beach.

Other Retirement Utopias. You need not go to California or Florida to find your retirement Utopia. From South Carolina through Georgia one can find coastal towns and cities interesting and suitable for retired people. Inland, there are many charming places where one can find pleasant and economical living. Along the Gulf Coast from Florida through Alabama, Mississippi, Louisiana and Texas you can find plenty of suitable places for happy retirement living. Some resemble in many ways the Florida coastal areas, and in many areas you will find greater employment opportunities. You may find the people of some of these communities more suitable as companions, having interests more like your own, than you may find in Florida. For instance, along the Texas coast, you can find persons interested in every phase of the oil business or cattle business. And you could easily engage in either of them, in some manner, should you so desire.

You may find your Utopia in the Ozone Belt of Louisiana, where doctors frequently send patients suffering from heart and lung diseases. The death rate in this Ozone Belt is less than two-thirds as great as for the United States as a whole. It is a popular retirement area that merits your consideration. Its climate is about the same as Florida's. If you like tall pine forests exuding a fragrant balm, pure artesian waters, medical springs, and closeness to the cosmopolitan city of New Orleans, this could well be the retirement spot for you.

El Paso has long been recommended as a home for those suffering from asthma, tuberculosis and other pulmonary diseases. Somewhat similar to the West Texas area are the areas of Southern New Mexico and Arizona, where the weather is never cold except in the mountainous areas. These areas, especially around

Tucson and Phoenix, are becoming very popular retirement areas. They have hot, dry climates and the sun shines practically all the daytime hours. If you like this kind of weather, vivid mountain scenery and friendly people, here may be your Utopia.

HOUSING

Communities for the Aged. Surveys have shown that over 68 percent of the families where the head of the house is over 65 own their own homes. Most old people who have tried to live with others advise you to keep your own household as long as possible. It is not likely you will ever be as happy any place as in your own home.

Most retired people who own their own homes stay where they have lived before retirement. But there is a trend towards moving to communities especially constructed for them, and where their neighbors are mostly old people. As these communities grow and are better known, this trend will probably increase.

Until recently most of the attention of home builders has been centered on providing homes for young people. There is a tremendous field now open to build homes for the aged in communities reserved principally for them. Real estate developers choose locations for subdivisions in which to construct such communities. Hundreds of houses may be built for a single community. Each is usually built according to standard ideas desirable in homes for the elderly. Ownership of a home in such a community frequently includes membership in a country club, a beach and a boating club, and other recreational facilities. Some of them include a hospital. Most of them include stores to supply most of your wants.

Not long ago, such a real estate developer and builder obtained a chunk of reformed desert near Phoenix, Arizona. On it he was building large numbers of homes for sale to persons over 50. He offered prizes for winning names for the development in a full-page advertisement in the *Saturday Evening Post*. This developing community for older people contains a golf course, olympic-sized swimming pool, outdoor archery range, lawn bowling, shuffleboard, horseshoe and croquet courts. Over 100,000 people visited it the first day and 237 homes were sold. The prices ranged between $8,500 and $11,300. This developer intends to continue building these communities for older people.

In Florida, one firm of builders who aim their pitch at retired couples, are developing a 94,000-acre tract not limited to older people, but principally for them. Over 250,000 homes could be built on such a tract without crowding. Another firm in Florida, that goes in for national radio advertising and for sales by mail, has obtained a tract which they call a paradise. Its beautiful sales brochure, illustrated in color, claims it to be "an amazing opportunity for investment, for happy living and for retirement." They claim "8,698 water-front home sites fronting on 138 miles of navigable waterways that lead to the Gulf. There are record-breaking trout, snook, bonita and channel bass and 4,349 inland sites with majestic waterview." Purchasers must agree to build within specified times in certain zones, but much of the tract has no building time limits. You can buy these quarter-acre homesites by mail for as little as $20 down and $20 per month, and you have six months in which to visit your purchase and get your money back if not satisfied.

Rest Homes. Churches, lodges, labor unions and other organizations frequently run rest homes for their elder members. Also, there are large numbers of them run by individuals for profit. Some of these are good, some fair and some very poor. Together, they do not take care of a large proportion of the older people, only about one in 25. Most of them require that when you enter you turn over to them all your assets including your Social Security benefits. Then, they look after you and supply all your needs for the rest of your life. If you change your mind, there is little you can do about it.

What The Future Promises. The striking promises of the future of housing for retired persons are many. Since there will be so many retired persons with good pensions and other income, as well as with money for good housing, there will be a thriving big business supplying this want. Individual homes, designed and built especially for old people, will be built perhaps in the millions. Probably, most of these will be grouped in communities conductive to activities of people over 50. All may use the recreational and cultural facilities of the community. Such homes will conform to some present standards of houses for the elderly—standards which will likely be improved.

There will no doubt be many large apartment houses constructed especially for the retired, either operated as businesses or as cooperative undertakings. A great opportunity for retirees having promotional and constructional abilities is to provide whole home communities of various types for the ever increasing crowd of retired persons. While as yet only a small part of the desirable locations for individual and community homes and apartments have been put to this use, the best ones are being rapidly used up. Buying in the path of progress has always been a very profitable undertaking for the wise. You might find it interesting and instructive to spend some of your vacations looking into where you wish to live in retirement. Then invest in a location while there is still plenty of choice and before the prices of the good locations advance greatly. If you choose rightly, as others have done, you could find such a purchase profitable. ##

About the Author

Forrest E. Gilmore was an engineering consultant and patent administrator in Phillips Petroleum Co.'s Refining Department before his retirement in 1958. He was a process engineering consultant, trouble shooter, and patent idea promoter. He also taught engineers how to invent, leading to his writing the book, "How to Invent," Gulf Publishing Co., Houston, 1959. Holder of a B.S. degree in civil engineering from Kansas State College, Mr. Gilmore owned his own gasoline-plant construction firm for about seven years, and has worked for Airolene and Philmore Gasoline companies, Frigid Transportation Corp., Black River Oil Co., and as an oil-properties representative. He joined Phillips' Gasoline Department in 1941, and through the years served as coordinator, administrative assistant to the vice president, assistant superintendent of operations, assistant chief processing engineer, engineering consultant and patent administrator.

Recent commercial-scale operations feeding heavy catalytic cycle oil and heavy straight run gas oil demonstrate the flexibility of the Isocracking process. See how latest design studies show substantial reductions in investments and operating costs for this process

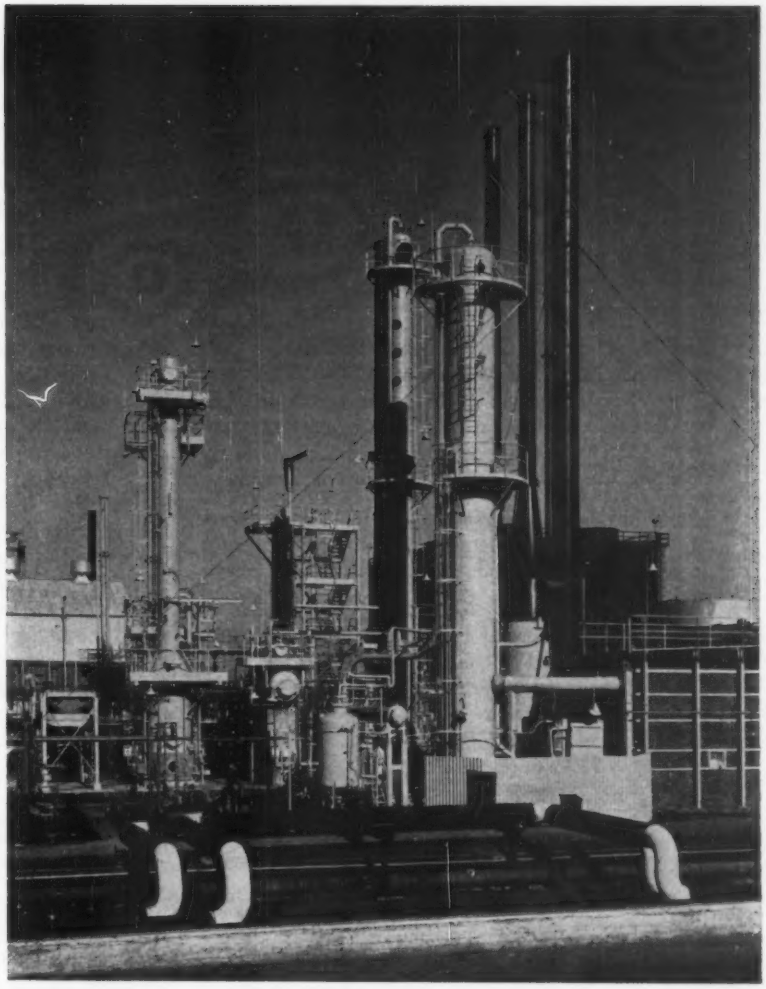


FIGURE 1—Isocracking has now been in commercial operation almost two years.

NOW REVISE THOSE HYDROCRACKING COSTS

J. A. Robbers and N. J. Paterson
California Research Corp., San Francisco

W. T. Lane, Standard Oil Company of California
San Francisco

Isocracking is a flexible process that can serve the refiner in many different roles. With the new lower costs and ability to process heavier gas oils, including cracked stocks, Isocracking now offers the refiner a powerful means to cope with the industry's changing economic problems and substantially improve his competitive position.

Isocracking today is a commercially proven, low temperature hydrocracking process—a method of cracking in the presence of hydrogen and a catalyst to convert low-value, high-boiling distillates to lower boiling, higher value liquid products with essentially no waste gas produced. The process is being analyzed by refiners throughout the world to solve problems such

as: balancing seasonal gasoline and distillate demands, relieving overloaded catalytic cracking plants, eliminating pour point problems on distillate fuels, upgrading oil field condensates, and obtaining the maximum yield of gasoline from a given crude run. It is this flexibility that makes Isocracking attractive.

Several important developments have occurred since the process was first announced. Of most significance are the following:

- End point limits on feed stocks to Isocracking have been increased. Isocracking of 800°-850° F end point heavy catalytic cycle oil and 850°-900° F end point straight run gas oil has been demonstrated in the 1,000-bpd plant in the Richmond refinery of the Standard Oil Company of California.
- Firm bid prices from contractors for the construction of various size Isocrackers show the costs for these plants will be about one third below the costs previously published.[1]
- Two large commercial Isocracking units presently are being designed or constructed. One is for Sohio at Toledo and the other is for Tidewater Oil Company at Avon. Other projects are reaching advanced stages of development.

The purpose of this paper is to present plant operating experience with heavier feed stocks and to show how the new lower costs make processing these stocks financially attractive.

THE RICHMOND ISOCRACKER

Isocracking is the first of the new hydrocarbon processes[1,2,3] to be placed in commercial operation. The 1,000-bpd Isocracking plant built by Standard Oil Company of California at the corporation's Richmond refinery now has been in operation almost two years. The distillation range of feed stock to this plant has been extended from the heavy cracked naphtha and light catalytic cycle oil previously reported[4] to heavy catalytic cycle oil and heavy California straight run gas oil. Product cut points in the plant operations have ranged from 320° F to 525° F with extinction recycle of higher boiling material.

Figure 1 is a photograph of the Richmond unit. The plant has operated with make-up hydrogen from the catalytic reformers in the refinery with hydrogen purities ranging from 68 to 90 volume percent. Unstabilized Isocrackate, taken as the overhead stream from the recycle splitter column, is returned to the catalytic reformers.

Plant operation with 600°-650° F end point feed

TABLE 1—Richmond Isocracker Operations. Heavy Catalytic Cycle Oil Feed California Crudes.

Inspections	Raw Feed	Hydrofined Stock	180-350° F Isocrackate	350 °F+ Jet Fuel
Gravity, °API	24.5	31.3	56.3	41.6
Aniline Point, °F	169	...	126.5	133.4
ASTM Distillation, °F	(D 1160)	...	(D 86)	(D 86)
Initial	557	...	213	332
10 Percent	624	...	232	388
30 Percent	652	...	241	397
50 Percent	687	...	257	409
70 Percent	717	...	278	424
90 Percent	758	...	310	449
EP	855	...	323	485
Composition, Volume Percent				
Paraffins	.....	...	43.2	} 79
Naphthenes	.....	...	46.1	
Aromatics	.....	...	10.7	21
Total		...	100	100
Sulfur, Weight Percent	0.46	...	....	....
Nitrogen, ppm	1310	...	....	....
Pour Point, ASTM, °F	+75	...	....	....
Freeze Point, °F	.....	...	....	—112
Octane Number				
Research Clear	.....	...	63	....
Research + 3 ml TEL	.....	...	81.8	....

Hydrogen Consumption, SCF/Bbl Raw Feed	
HDN Process Unit	970
Isocracker	1440
Total	2410

	Observed	Adjusted*
Plant Yields		
Hydrofined Stock, Vol. Percent of Raw Feed	104.9	....
Isocracker Gas Yields, Wt. % of Hydrofined Stock		
C_1	—0.5	0.01
C_2	—0.7	0.2
C_3	0.6	0.6
Total	—0.6	+0.81
Isocracker Liquid Yields, Vol. % of Raw Feed		
iC_4	7.9	7.8
nC_4	3.1	3.1
C_5-180° F, Light Isocrackate	29.6	28.8
180-350° F, Heavy Isocrackate	60.6	58.5
350-500 °F, Jet Fuel	29.2	28.7
Total	130.4	126.9

* Adjusted for material balance closure.

TABLE 2—Richmond Isocracker Operations. Inspections of Jet Fuel Produced from Heavy Catalytic Cycle Oil.

Inspection	Method	Typical Commercial Airline Specifications	Plant Results
Gravity, °API	ASTM D 287	37-57	41.6
Distillation, °F	ASTM D 86	.....	.....
10 Percent	.....	400 max	388
50 Percent	.....	450 max	409
EP	.....	550 max	485
Flash Point, °F	ASTM D 56	110-150	115
Freezing Point, °F	IP-16B	—58 max	—112 to below —121
Viscosity, cs	ASTM D 445	.....	.....
At 0° F	.....	.....	4.8
At —30° F	.....	15.0 max	8.9
Sulfur, Weight Percent	ASTM D 90 or D 1266	0.3 max	0.0004
Aromatics, Volume Percent	ASTM D 1319	20 max	21
Smoke Point, mm	ASTM D 1322	25 min*	19
Naphthalenes, Vol. Percent	FS 3704T	3.0 max	0.3

* Waived provided naphthalene content does not exceed 3.0 volume percent.

TABLE 3—Richmond Isocracker Operation. Heavy Straight Run Gas Oil.

Inspections	Raw Feed	Hydrofined Feed	350° F + Jet Fuel Stock
Gravity, °API	22.0	28.2	39.8
Aniline Point, °F	147.2	150.6	127.9
Distillation, °F	(D 1160)	....	(D 86)
Initial	532	....	356
10 Percent	651	....	371
30 Percent	687	....	387
50 Percent	715	....	409
70 Percent	745	....	437
90 Percent	785	....	475
EP	880	....	503
Composition, LV Percent			
Paraffins + Naphthenes	.....	....	78
Aromatics	.....	....	22
Sulfur, Weight Percent	0.70	....	.....
Nitrogen, ppm	2150	....	.....
Pour Point, °F	+35	....	.....
Freezing Point, °F	.....	....	—88.6

TABLE 4—Process Plant Investment, 7000 BPOD Light Cycle Oil Feed California Crude.

	DOLLARS	
	HDN Process	Isocracker Extinction Recycle
1. **Direct Labor and Material**		
a. **Reactor Section**—Includes feed pump, heat exchange, charge heater, make-up hydrogen and recycle compressors, reactors, and flash drums	1,050,000	1,700,000
b. **Recovery Section**—Includes stabilizer, depropanizer, recycle splitter, and side cut stripper	*	720,000
2. **Indirect Field Expenses**—Includes erection contractor's fee, contractor's field office expense, construction equipment rental, hand tools and consumable supplies expense, and temporary lines and buildings	300,000	460,000
Total Process Plant Investment	1,350,000	2,880,000

* Product stripper included in reactor section.

stocks was directed toward demonstrating the commercial feasibility of high quality gasoline manufacture. The close relationship between the commercial Isocracker performance and pilot plant operation for light catalytic cycle oil has already been reported.[4] Isocracking of heavier feeds has been directed toward a commercial demonstration of the flexibility of the same plant to produce low freeze point jet fuel as well as gasoline.

Table 1 summarizes feed stock inspections, yields, product inspections, and hydrogen consumption for operations in the Richmond Isocracker feeding 500°-855° F heavy catalytic cycle oil obtained from the nearby fluid catalytic cracker. The whole Isocrackate was split into a 350° F end point gasoline fraction and a 350°-500° F boiling range jet fuel stock. Detailed inspections of the jet stock are presented in Table 2. The plant yields correspond closely to similar data obtained in our pilot plants.

The observed plant yields indicate negative gas values or a disappearance of methane and ethane. Net gas yields are obtained by difference where the light hydrocarbons introduced with the make-up hydrogen are far greater than produced by the Isocracking reactions. These negative yields can be attributed to slight inaccuracies in the plant flowmeters. Methane and ethane yields shown in the adjusted data column were estimated from pilot plant data.

A significant feature of this commercial-scale operation was the 29 volume percent yield of minus 112° F freeze point kerosine jet fuel made from plus 75° F pour point feed. Simultaneously, a 98 volume percent yield of C_4 to 350° F end point gasoline stock was produced. Higher yields of kerosine-type jet can be made at the expense of gasoline production.

Table 3 shows the inspections of plant feed and the jet fuel stock produced in a plant test program feeding 550°-880° F boiling range heavy straight run gas oil from California crudes. Complete inspections on the plant streams are now being obtained. These and the resulting yields will be available later.

The Richmond plant operation on heavy feeds demonstrates that, with Isocracking, the refiner can readily meet increasing jet demands without expanding crude runs that would throw other products out of balance.

Valuable engineering data and operating experience have been gained from these commercial plant programs. Corrosion specimens have been exposed to actual operating environments. Background information has been accumulated on startup and shutdown procedures and on regeneration of HDN catalyst—i.e., catalyst in the pretreating process designed to remove sulfur and nitrogen compounds and prepare stocks for the Isocracker. Use of this information, along with the wealth of pilot plant data, makes it possible to apply Isocracking with confidence in a variety of refinery situations.

INVESTMENT AND OPERATING COSTS

Detailed process and mechanical design studies have been completed for several Isocracking projects. These engineering studies have led to substantial reductions in the investment and operating costs reported previously.[1] Investments for a 7,000-bpod HDN Process and Isocracking units feeding California catalytic cycle oil are shown in Table 4. Direct labor and material costs are indicated along with the indirect field expenses required for plant erection. The totals exclude off-plot facilities, catalysts for the first plant charge, and design engineering expenses.

Utility requirements and estimated operating costs are shown in Table 5 for the same 7,000-bpod cycle oil plants. The investment and operating costs include hydrogen make-up compression facilities. Availability of an 85 percent purity hydrogen stream at battery limits at 300 psig has been assumed in estimating the compression requirements.

For More Details on This Process, See These Other Articles in Petroleum Refiner:

"How Isocracking Works," Vol. 39, No. 4, pp 155-60 (1960).

"How Much You Can Save With The Isocracking Process," Vol. 39, No. 5, pp 161-8 (1960).

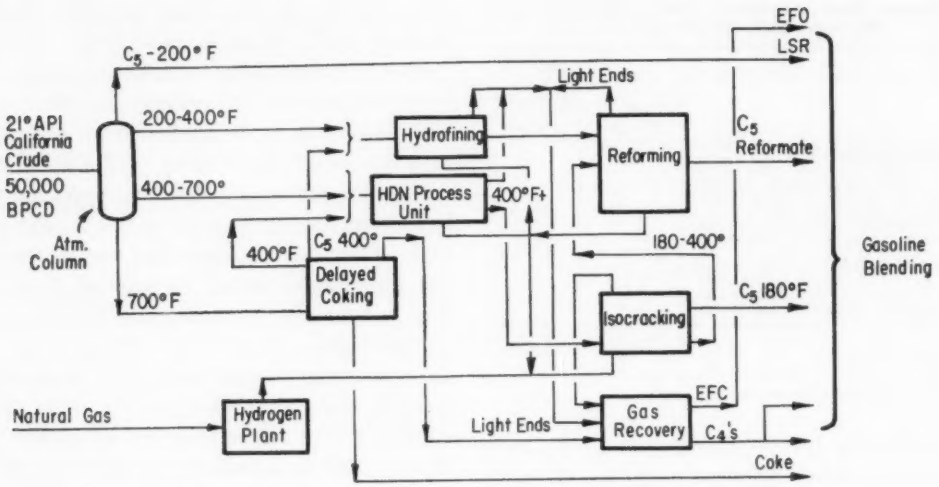


FIGURE 2—Here is the process flow for the combination of Isocracking and coking.

REFINERY ECONOMICS

Two studies will show the economic attractiveness for typical Isocracking applications. The first study illustrates the combination of Isocracking with either coking or visbreaking; the second study illustrates how Isocracking may be added to a refinery currently limited by its catalytic cracking capacity. Isocracking is easily integrated into existing refinery facilities.

Isocracking in Combination with Coking or Visbreaking. A 50,000-bpcd refinery was selected to illustrate how Isocracking may be combined with various residuum conversion processes. Two cases are presented for a 21° API gravity California crude. In one case, the residuum from the atmospheric crude column is processed in a delayed coker; in the second case, it is processed in a visbreaker. The block flow diagrams for these two cases are shown in Figures 2 and 3. The processing rates and the product yields are shown in Table 6. The gasoline inspections are summarized in Table 7. Isocracking yields and product inspections used for these case studies are shown in Table 8.

An objective of this study was to maximize gasoline production from crude and eliminate the production of middle distillates. The only other product is coke or No. 6 fuel oil.

TABLE 5—HDN Process Unit and Isocracker Operating Costs. 7000 BPOD Light Cycle Oil Feed California Crude.

	Unit Cost, Dollars	HDN Process			Isocracker Extinction Recycle to 400 °F		
		Consumption	¢/bbl		Consumption	¢/bbl	
Utilities							
Fuel, BPOD-EFO	2.00/bbl	60	1.7	.....	305	8.7	.....
Power, kw	0.008/kw-hr	....	..	.....	....	..	.....
Compressors	.....	870	2.4	.....	2620	7.2	.....
Pumps and Lights	.....	280	0.8	.....	750	2.0	.....
Deaerated Condensate, lb/hr	0.03/M lb	8500	0.1	.....	....	..	.....
150 psig Steam, lb/hr	0.47/M lb	....	..	.....	4600	0.7	.....
Cooling Water, gpm (85-120 °F)	0.02/M gal	510	0.2	.....	3300	1.4	.....
Subtotal	.....	....	..	5.2	....	..	20.0
Catalyst and Chemicals				6.4			10.3
Labor							
Direct Labor (Operators)	.....	(One)	1.3	.....	(Two)	2.6	.....
Supervision	.....	....	0.7	.....	....	0.7	.....
Analytical and Tech. Service	.....	....	0.7	.....	....	0.7	.....
Subtotal	.....	....	..	2.7	....	..	4.0
Maintenance							
4 Percent of Investment	.....	....	...	2.4	....	...	5.0
Plant Overhead							
15 Percent of Labor and Maintenance	.....	....	...	0.8	....	...	1.4
Property Taxes and Insurance							
2½ Percent of Investment	.....	....	..	1.5	....	...	3.1
Total, ¢/bbl	.....	....	...	19.0	....	...	43.8
$/OD	.....	....	...	1330	....	...	3070

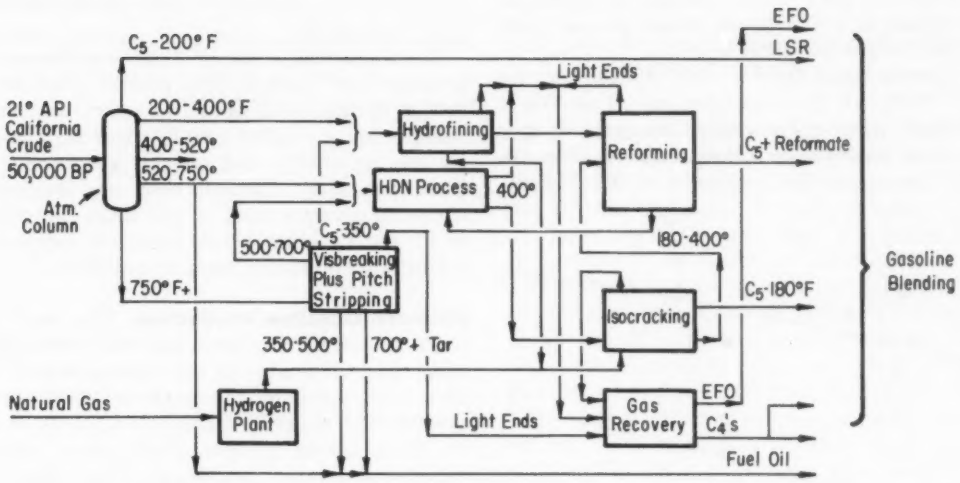


FIGURE 3—This is the way the flow would look when Isocracking is combined with visbreaking.

In the coking case, the 400°-700° F straight run gas oil is combined with the 400°-700° F coker distillate and fed to the HDN Process-Isocracker plant. The heavy straight run naphtha and the coker naphtha are hydrofined and fed to a catalytic reformer. The heavy Isocrackate does not require pretreating and is fed directly to the platinum reformer. A total of 46,208

TABLE 6—Isocracking Refinery Balances. 50,000 BPCD of 21° API California Crude.

	Isocracking Visbreaking	Isocracking Coking
Processing Rates, BPCD		
Single-Stage Crude Unit	50,000	50,000
Reformer		
Hydrofining	10,224	15,486
Reforming	22,350	37,390
HDN Process Unit and Isocracker	16,430	27,726
Visbreaking	25,054	.....
Coking	.....	27,004
Hydrogen Plant, M SCF/Day*	28.4	46.1
Products, BPCD		
Premium Gasoline (40 Percent)	12,095	18,484
Regular Gasoline (60 Percent)	18,143	27,724
Total	30,238	46,208
Fuel Oil (175 SSF/122° F)	21,644	.....
Coke, tons/day	.....	992
Excess Butanes	1,212	2,742
Fuel Gas (Equivalent Fuel Oil)	2,540	6,312

* 100 Percent hydrogen basis.

TABLE 7—Isocracking Refinery Balances. 50,000 BPCD of 21° API California Crude. Gasoline Quality

Processing	Isocracking—Coking		Isocracking—Visbreaking	
Grade	**Premium**	**Regular**	**Premium**	**Regular**
Octane Number				
Research	100.5	92.0	100.5	92.0
Motor	91.5	86.0	91.5	86.0
TEL, ml/gal	1.7	1.8	1.7	1.8
ASTM Distillation (D 86), °F				
50 Percent	235	245	235	245
90 Percent	345	360	345	360
RVP, psi	10	10	10	10
Bromine No., g/100 g	1	1	1	1

TABLE 8—Estimated Isocracking Yields and Product Inspections. Isocracking in Combination with Coking or Visbreaking.

Feed Stock	Coking Case 400—700 °F Straight Run Gas Oil 400—700 °F Coker Distillate		Visbreaking Case 400—750 °F Straight Run Gas Oil 500—700 °F Visbreaker Gas Oil	
Gravity, °API	27.8		21.2	
Aniline Point, °F	126		136	
ASTM Distillation (D 1160)., °F				
Initial	370		370	
10 Percent	445		475	
50 Percent	570		600	
90 Percent	648		688	
EP	700		750	
Sulfur, Wt. Percent	1.9		1.9	
Nitrogen, ppm	1700		1350	
Yields, Weight Percent of Raw Feed	**HDN Process**	**Isocracker**	**HDN Process**	**Isocracker**
C_1	0.25	0.01	0.23	0.01
C_2	0.35	0.11	0.32	0.07
C_3	0.35	2.6	0.33	2.4
C_4	0.30	.....	0.29	.....
Yields, LV Percent of Raw Feed				
iC_4	.....	11.6	.....	11.0
nC_4	.....	4.2	.....	4.5
C_5-180 °F	.....	25.3	.....	26.0
180-400 °F	.....	79.0	.....	82.9
Total C_4 +	.....	120.1	.....	124.4
Total C_5 +	102.8	104.3	104.9	108.9
H_2 Consumption, SCF/bbl Raw Feed	1050	1000	1180	1010
Product Inspections	**C_5-180 °F Light Isocrackate**	**180-400 °F Heavy Isocrackate**	**C_5-180 °F Light Isocrackate**	**180-400 °F Heavy Isocrackate**
Gravity, °API	84	52	82	50
Aniline Point, °F	...	125	...	114
ASTM Distillation, (D 86.), °F				
Initial	95	215	95	215
10 Percent	100	245	100	245
50 Percent	140	295	140	285
90 Percent	150	360	150	370
EP	190	410	190	410
Composition, LV %				
Paraffins	85	40	81	31
Naphthenes	11	45	14	53
Aromatics	4	15	5	16
Total	100	100	100	100
Octane Number				
Research Clear	86	61	88	64
Research + 3 ml TEL	99	80	100	81
Motor + 3 ml TEL	100	80	101	82

bpcd of 10-pound RVP motor gasoline is produced. This corresponds to a 92.4 liquid volume percent yield of finished motor gasoline from crude.

In the visbreaker case, the 500°-700° F visbreaker gas oil and the 400°-750° F straight run gas oil are fed to the HDN Process-Isocracker plant. Other processing is similar to that used in the coking refinery. The 10-pound RVP motor gasoline production of 30,238 bpcd, in this case, corresponds to a 60.5 liquid volume percent yield from crude.

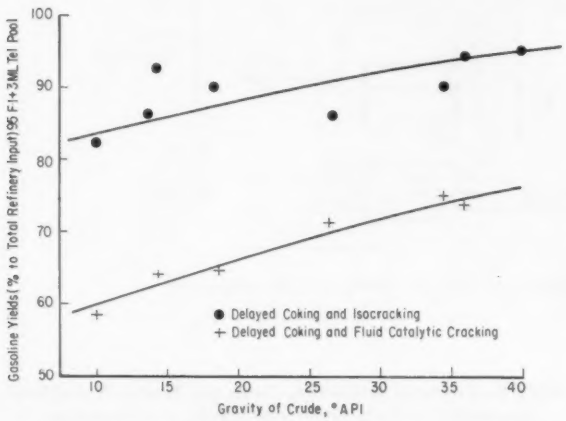


FIGURE 4—Better gasoline yields are achieved when using Isocracking.

Economic evaluations of these two refinery cases are presented in Table 9. The process plant investments shown do not include allowances for engineering charges, initial catalyst cost, or royalties. The estimated engineering charges and off-plot investments are indicated separately. Catalyst costs are included in the operating cost for each of the units. Project payouts of 1.9 and 2.1 years, before taxes, are indicated for the coking and visbreaking cases, respectively.

Ultimate Gasoline Production. The results of additional studies for maximum gasoline production from a wide range of crude oils are summarized in Figure 4. This figure compares the maximum gasoline yields attainable with either fluid catalytic cracking or Isocracking in a coking refinery. Only heavy straight run naphtha and heavy Isocrackate were catalytically reformed. In the fluid catalytic cracking cases, the C_3 and C_4 olefins were alkylated. The gasoline pool in all cases was blended to 10 pounds RVP and 95.2 F-1 + 3 ml TEL.

The ability of Isocracking to produce high yields of gasoline stocks from refractory middle distillates now permits the realization of increased gasoline yields from crude. Isocracking does not produce the high gas and

TABLE 9—Economic Evaluation—Isocracking in Combination with Coking or Visbreaking.

	Isocracking-Coking			Isocracking-Visbreaking		
	BPCD	Investment, $ Million		BPCD	Investment, $ Million	
Estimated Investments						
Materials and Direct Labor						
Atmospheric Crude Unit	50,000	1.5		50,000	1.6	
HDN Process	27,726	5.5		16,430	3.2	
Isocracker	28,500	9.5		17,250	6.0	
H_2 Plant (M SCF/CD-H_2)	(46.1)	4.4		(28.4)	2.8	
Catalytic Reformer—Hydrogenation Stage	15,486	2.0		10,224	1.4	
—Reforming Stage	39,390	6.4		22,350	4.1	
Coker	27,004	5.9		.....	...	
Visbreaker and Tar Stripper	.....	...		25,054	2.9	
Subtotal	.....	35.2		.....	22.0	
Indirect Field Expenses and Engineering	.....	7.5		.....	5.6	
Onplot	.....	...	42.7	.....	...	27.6
Offplot	.....	...	27.0	.....	...	19.0
Total Investment	.....	...	69.7	.....	...	46.6
Product Realization		**$ Million/Yr.**			**$ Million/Yr.**	
Motor Gasoline { 40 Percent Premium @ $5.25/bbl { 60 Percent Regular	46,208	88.5	...	30,238	57.9	...
Butanes @ $3.50/bbl	2,742	3.5	...	1,212	1.5	...
Fuel Oil @ $1.90/bbl	.....	...	...	21,644	15.0	...
Fuel Gas (EFO) @ $2.00/bbl	6,312	4.6	...	2,540	1.9	...
Coke (tons) @ $4.00/ton	(992)	1.4	...	.....	...	...
Subtotal	.....	...	98.0	.....	...	76.3
Input						
21 °API California Crude @ $2.30/bbl	50,000	42.0	...	50,000	42.0	...
TEL (Liters/Day) @ $2.20/liter	(3420)	2.8	...	(2240)	1.8	...
Subtotal	.....	...	44.8	.....	...	43.8
Operating Costs	¢/bbl			¢/bbl		
Crude Unit	4	0.7	...	4	0.7	...
HDN Process	21	2.1	...	21	1.3	...
Isocracker	38	4.0	...	40	2.5	...
H_2 Plant (¢/M SCF-H_2)	(24)	4.0	...	(24)	2.5	...
Catalytic Reformer—Hydrogenation Stage	10	0.6	...	11	0.4	...
—Reforming Stage	23	3.1	...	24	2.0	...
Coker	20	2.0	...	.....	...	...
Visbreaker	.....	...	...	11	1.0	...
Subtotal	.....	...	16.5	.....	...	10.4
Amount Available for Payout	.....	...	36.7	.....	...	22.1
Payout Period, Years						
Before Taxes		1.9			2.1	
After Taxes (52% Income Tax; 10% Straight Line Depreciation)		3.3			3.6	

Note: HDN and Isocracker costs in this table are for heavy cracked gas oils.

TABLE 10—Estimated Isocracking Yields and Product Inspections. Isocracking-Catalytic Cracking Combination.

Feed Stock	650-850 °F Heavy Straight Run Gas Oil 640-780 °F Heavy Cycle Oil
Gravity, °API	31.4
Aniline Point, °F	171
ASTM Distillation, (D 1160), °F	
Initial	330
10 Percent	608
50 Percent	690
90 Percent	789
EP	862
Composition, LV Percent	
Paraffins + Naphthenes	77
Olefins	0
Aromatics	23
Total	100
Sulfur, Weight Percent	0.81
Nitrogen, ppm	387
Pour Point, °F	+60

Yields, Wt. % of Raw Feed	HDN Process	Isocracker
C_1	0.06	0.003
C_2	0.07	0.04
C_3	0.08	1.2
C_4	0.09	.....
Yields, LV % of Raw Feed		
iC_4	.....	5.8
nC_4	.....	2.4
C_5-180 °F	.....	18.0
180-360 °F	.....	44.5
360-600 °F	.....	45.8
Total C_4+	.....	116.5
Total C_5+	103.3	108.3
Hydrogen Consumption, SCF/bbl Raw Feed	450	850

Product Inspections	C_5-180 °F Light Isocrackate	180-360 °F Heavy Isocrackate	360-600 °F No. 1 Oil
Gravity, °API	85	57	44
Aniline Point, °F	....	125	160
ASTM, Distillation, °F	(D 86)	(D 86)	(D 158)
Initial	95	215	380
10 Percent	100	240	....
50 Percent	140	270	460
90 Percent	150	320	....
EP	190	360	610
Composition, LV Percent			
Paraffins	80	48	88
Naphthenes	15	42	
Aromatics	5	10	12
Total	100	100	100
Octane Number			
Research Clear	88	53	....
Research + 3 ml TEL	100	76	....
Motor + 3 ml TEL	101	78	....
Diesel Index	....	....	70.5
Cetane Number	....	....	60
Pour Point, °F	....	....	—30

coke yields from refractory cracked gas oils encountered with other conversion processes.

Isocracking in Combination with Fluid Catalytic Cracking—Increased Crude Input. Isocracking also lends itself to integration with an existing catalytic cracker. An expanding refinery situation was selected to demonstrate the economics for Isocracking heavy feed stocks. It is desired to increase crude runs from 31,500 bpcd to 45,000 bpcd, minimize No. 6 fuel oil production, and convert all 550°-1050° F boiling range heavy gas oil into motor gasoline and low pour No. 1 oil. Crude input to the refinery is a 34.5° API paraffinic base crude. At the 31,500 bpcd crude input, the existing fluid catalytic cracker is assumed to be gas and coke limited when feeding 14,400 bpcd at 57 percent conversion. The refinery processes light catalytic cycle oil in an existing hydrodesulfurization unit for No. 2 oil quality improvement.

Two alternatives were considered. The first was to increase conversion on an existing fluid catalytic cracker and install a new 10,700-bpcd fluid catalytic cracking unit together with additional alkylation capacity to handle the incremental C_3 and C_4 olefins. The other was to install an 8,800-bpcd Isocracker operating on a mixture of straight run and heavy catalytic cycle oil boiling from 500°-850° F. The yields and product inspections for the HDN Process-Isocracker plant are shown in Table 10. The refinery processing unit feed rates and product yields are shown in Table 11.

At the expanded crude run, gasoline production and research octane are maintained constant in both cases and production of low pour No. 1 oil is increased. There is an improvement in gasoline pool sensitivity for the Isocracker case for which no credit is taken in the economic evaluation. Incremental No. 1 oil production in the Isocracker case is —30° F pour point.

In the catalytic cracker case, the incremental light cycle oil is hydrofined and sold as No. 2 oil product.

TABLE 11—Processing Rates and Investments. Isocracking-Catalytic Cracking Study. 45,000 BPCD of 34.5° API Paraffinic Crude.

	Base	I			II		
		Additional Catalytic Cracking			Isocracking		
Case	Existing Units, BPCD	Existing Units, BPCD	New Units, BPCD	Investment, $ Million (Material + Direct Labor)	Existing Units, BPCD	New Units, BPCD	Investment, $ Million (Materials + Direct Labor)
Processing Plants							
Crude Unit	31,500	45,000			45,000		
Catalytic Cracking	14,400	9,000	10,700	4.3	12,000		
Conversion, Percent	57	75	75		65		
Recycle, Percent	25	100	100		50		
Coke Burning, lb/hr	14,000	14,000	17,000		14,000		
C_3-C_4 Alkylation (Product)	1,920	1,920	2,410	1.9	1,860		
C_3 Polymerization (Product)	523	523			516		
Light Cycle Oil Hydrofining	3,170	3,940		0.2*	2,510		
Catalytic Reforming	5,940	8,090		0.6*	5,940	7670	1.8
HDN Process				..		8820	1.8
Isocracking				..		9200	3.6
H_2 Plant (M SCF/CD-H_2)				..		(6.0)	0.8
Subtotal-Materials and Labor				7.0			8.0
Indirect Field Expenses and Engineering				3.2			2.5
Onplot				10.2			10.5
Offplot				4.0			3.5
Total Investment				14.2			14.0

* Estimated investment for expanding existing facilities.
Note: HDN and Isocracker costs in this table are for heavy cracked gas oils.

TABLE 12—Economic Evaluation. Isocracking-Catalytic Cracking Study.

Case	Base	I			II		
Investment, $ Million	Existing Units	Additional Catalytic Cracking			Isocracking		
		14.2			14.0		
	BPCD	△BPCD		$ Million/Yr	△BPCD		$ Million/Yr
Product Realization							
Motor Gasoline (99 F-1 + 3 ml TEL) @ $5.67/bbl	8,862	6667		13.80	6667		13.80
(Sensitivity)	(11.8)	(11.1)			(9.5)		
No. 1 Oil @ $4.40/bbl					2011		3.23
No. 2 Oil @ $4.00/bbl	3,168	774		1.13	—654		—0.96
No. 6 Oil @ $2.30/bbl	3,026	—2040		—1.71	—2427		—2.04
Isobutane @ $3.78/bbl					902		1.24
Fuel Gas (EFO) @ $2.00/bbl	1,344	871		0.64	—97		—0.07
Subtotal				13.86			15.20
Input							
Gas Oil Feed (550-1050 °F) @ $2.52/bbl	14,400	5310		4.88	5310		4.88
Isobutane @ $3.78/bbl	812	986		1.36			
n-Butane @ $2.52/bbl	526	395		0.36	—24		—0.02
TEL (Liters/Day) @ $2.20/liter		(840)		0.67	(840)		0.67
Subtotal				7.27			5.53
Operating Costs		¢/bbl	△BPCD		¢/bbl	△BPCD	
Crude Unit		4[1]	13,500	0.20	4[1]	13,500	0.20
Catalytic Cracking		44	10,700	1.72			
Alkylation		120	2,410	1.05	50[2]	—60	—0.02
Polymerization					20[2]	—7	
Hydrofining		15[1]	770	0.04	10[2]	—660	—0.02
HDN Processing					27	8,820	0.87
Isocracking					43	9,200	1.44
Catalytic Reforming		25[1]	2,150	0.20	28	7,670	0.78
H_2 Plant (¢/M SCF-H_2)					(27)	(6.0)	0.59
Subtotal				3.21			3.84
Amount Available for Payout				3.38			5.83
Payout Period, years							
Before Taxes				4.2			2.4
After Taxes (52% Income Tax and 10% Straight Line Depreciation)				6.0			4.0

[1] Incremental operating cost. [2] Incremental savings.
Note: HDN and Isocracker costs in this table are for heavy cracked gas oils.

No catalytic reforming is required. It is assumed the existing reformers can handle the 2,150-bpcd incremental straight run feed stock resulting from the expanded crude run. If a requirement of the catalytic cracking case is to meet the same gasoline sensitivity as produced with the Isocracking case, then it would be necessary to shut down the existing Polymer plant, alkylate all the C_3 olefins, and install additional two-stage catalytic reforming capacity for the heavy catalytic gasoline.

Make-up hydrogen for the HDN process unit and Isocracker is obtained from the following sources: (1) excess hydrogen from the existing reformer operation on straight run gasoline, (2) hydrogen produced from reforming heavy Isocrackate, and (3) manufactured hydrogen. The total average demand for hydrogen is 14.5 $\overline{M}$ standard cubic feet per calendar day based on a 100 percent hydrogen basis. The average hydrogen demand from the hydrogen manufacturing plant is 6.0 $\overline{M}$ standard cubic feet per calendar day. This rate includes allowances for losses, leaks, and dissolved hydrogen.

The economic evaluations for the catalytic cracking and Isocracking alternatives are presented in Table 12. The Isocracking project investment is lower, and the funds available for payout are substantially higher for this case than for the catalytic cracking case. The payout period for Isocracking is about 2.4 years, compared with the 4.2 years for fluid catalytic cracking. These are on a before-tax basis.

Original presentation was before the Western Petroleum Refiners Association, San Antonio, Texas, April 12, 1961.

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Key Words for Indexing

Analysis (composition)
Catalysis
Compositions
Construction
Costs
Cracking (chemical)
Distillates
Distillation
Fuels
Gasolines
Hydrogen
Hydrogenation
Installations
Investments
Kerosine
Nitrogen
Operating
Performance
Recycle
Sulfur
Treaters
Yield

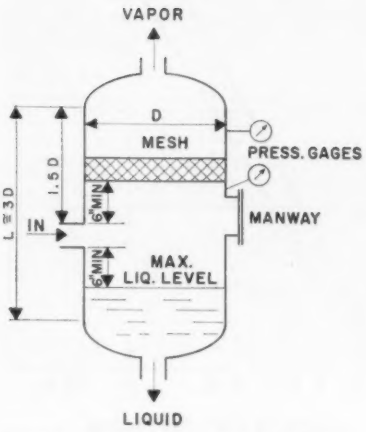

FIGURE 1—Vertical knockout drum for light mist entrainment (less than 1 gpm of liquid separated).

Check These Points When Designing Knockout Drums

For light mist entrainment (less than 1 gpm of liquid separated) use a vertical drum. For heavy vapor-liquid separations, use a horizontal drum

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Knockout drums are vessels especially designed to separate liquids from vapor. Most applications have been in the separations of water and oil from air or gas, the recovery of gas-oil drips from vacuum systems, the reduction of entrainment in compressor suctions and interstages and, the elimination of liquid drips in gas transmission lines. Their continued use in these services is due to simplicity of design, high performance and lower costs compared to other separation methods.

Selection and Design. Although there are other methods used to separate liquids from vapors, one of the most widely applied separation techniques is that of liquid impingement on wire mesh. The widespread use of this technique is due to the very high degree of separation attainable at minimum pressure drops.

Knockout drums consist of vertical or horizontal vessels with a wire mesh sandwich installed horizontally as illustrated in Figures 1 and 2.

Vertical or Horizontal. The question of when to provide a vertical or horizontal drum depends on the relation between the liquid and vapor loads. It is best to provide a vertical vessel for mist removal from vapors because of the small amount of liquid holdup space required (less than 1 gpm of liquid separated) as shown in Figure 1.

Horizontal vessels are provided for substantial vapor-liquid separation (greater than 1 gpm of liquid separated) where the liquid holdup space must be large, as in Figure 2.

Sizing the Drum. Quick sizing of the drum can be accomplished most easily by the use of charts specially prepared for this purpose.[1] The diameter chosen is then checked using the maximum allowable vapor velocity through the mesh to prevent liquid re-entrainment as determined from the equation:

$$U_a = K\sqrt{\frac{P_l - P_g}{P_g}}$$

where

U_a = vapor velocity, ft./sec.
P_l = liquid density, lbs./cu. ft.
P_g = vapor density, lbs./cu. ft.

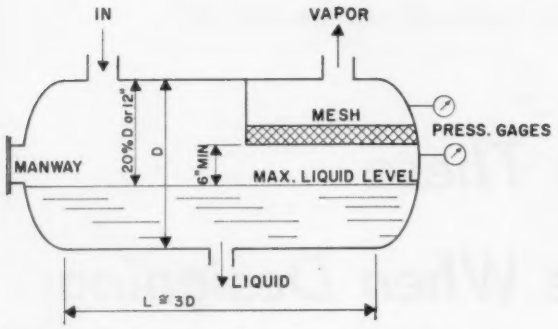

FIGURE 2—Horizontal knockout drum for heavy vapor-liquid separations (greater than 1 gpm of liquid separated).

K = 0.35 for normal process conditions. For abnormal conditions, a lower K value may be required and mesh manufacturers should be consulted for their recommendations.[2]

The minimum safe design velocity is 10 percent of U_a.[3,4] The maximum design velocity should be set at 75 percent of U_a to allow for gas surges.[3]

Further drum dimensions are based on rules designed to provide adequate liquid holdup and vapor disengaging space. For instance, the minimum vapor space in a horizontal drum is equal to 20 percent of the diameter or 12 inches whichever is the greater.

For a vertical drum, the desired vapor space is at least 1½ times the diameter with 6 inches being the minimum above the top of the inlet nozzle. In addition, a 6 inch minimum is required between the maximum liquid level and the bottom of the inlet nozzle.

The dimensions of the drums are kept in the ratio of approximately 3-to-1 length to diameter.

Sometimes the pressure available for separation is so low that the greater static head required to enter the vertical drum prevents its use.

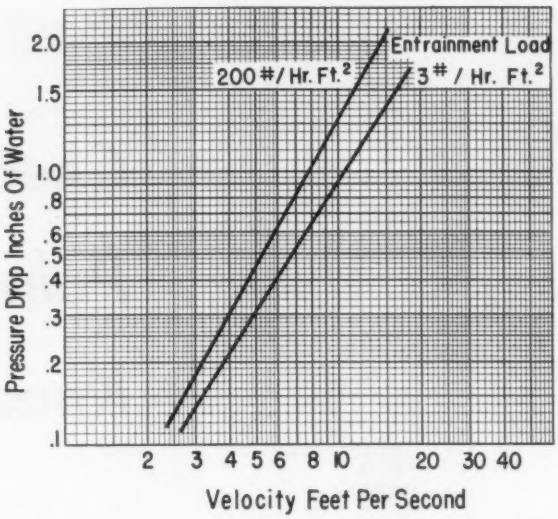

FIGURE 3—Typical chart for checking mesh thickness.

Drum Accessories. Other items added to these drums are pressure gages above and below the mesh to check the pressure drop and manways to install, work on or replace the mesh.

Wire Mesh. There have been no standard equations developed for the pressure drop through wire mesh because the mesh itself has not been standardized and each manufacturer makes a standard high efficiency, very high efficiency, or high throughput mesh under various trade names each of which has been developed for the specific purpose. The final drum diameter is determined by checking a particular manufacturer's chart for the vapor velocity, entrainment load and pressure drop through the particular pattern of mesh chosen (See Figure 3). Should the pressure drop be too high or low, the diameter would then be adjusted until it is acceptable.

Because of the large amount of free volume in the mesh, the pressure drop is so low that in most applications, it is negligible and 4 inches of mesh will be sufficient to give over 99.9 percent separation efficiency. Where the entrainment consists of a very fine mist or fog, one to two feet may be required.[2]

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About the Author

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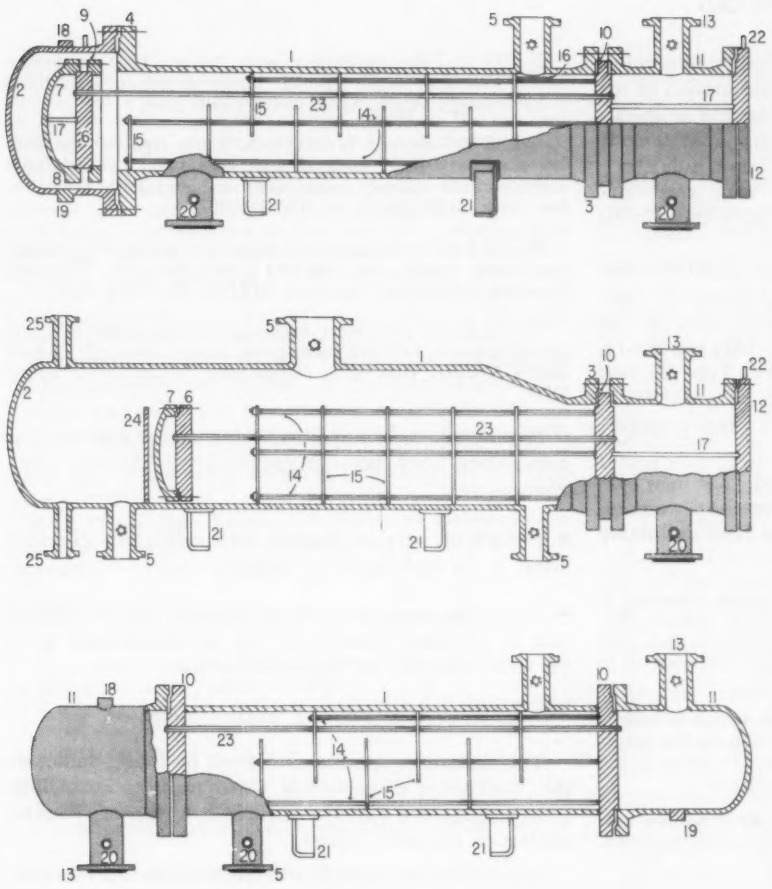
Key Words for Indexing

Demisters
Mists
Removal
Separation
Entrainment
Impinging
Meshes
Wires
Vessels



1. Shell
2. Shell Cover
3. Shell Flange Channel End
4. Shell Flange Cover End
5. Shell Nozzle
6. Floating Tubesheet
7. Floating Head Cover
8. Floating Head Flange
9. Floating Head Backing Device
10. Stationary Tubesheet
11. Channel or Stationary Head
12. Channel Cover
13. Channel Nozzle
14. Tie Rods and Spacers
15. Transverse Baffles or Support Plates
16. Impingement Baffle
17. Pass Partition
18. Vent Connection
19. Drain Connection
20. Instrument Connection
21. Support Saddles
22. Lifting Lugs
23. Tubes
14. Weir
25. Liquid Level Connection

FIGURE N-1—Heat exchanger component nomenclature. This illustrates floating head type, kettle type reboiler and fixed tubesheet exchangers. Typical parts are numbered and shown in the table above.

What are the differences?

New TEMA Standards Compared to Old

"TEMA R and TEMA C are meaningful specifications; TEMA alone is not." The new fourth edition adds a size numbering system. Here are the details

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Standards of the Tubular Exchanger Manufacturers Association (commonly called TEMA Standards) were revised in 1959, made available in 1960 and have been slightly modified since. The most significant changes between the third edition and the fourth edition, 1959 include:

- **Addition of size numbering and type designation.**
- **Deletion of TEMA Class "A" requirements for alloy construction.**
- **Deletion of standard TEMA flange dimensions.**
- **Deletion of TEMA "R" requirements for high hub flanges, for major exchanger flanges and for nozzle connections.**
- **Increased thickness requirements for channel covers of multipass units.**
- **Addition of "seal welding" and "strength welding" requirements for tube to tubesheet joints.**

The current edition of the Standards incorporates extensive revision in scope and mode of presentation, including additions to bring its recommended design data and procedures in line with the best current practices. It also contains much new information on mechanical standards and physical properties which was not available for previous editions. Certain other reference material in fields now undergoing extensive developmental changes has been eliminated from these Standards to reduce the need for continued revisions.

Confusion and lost time in the processing of orders for heat exchangers will be avoided by specifying the Mechanical Standard Class, R or C, to which the manufacturer must adhere. "TEMA R" and "TEMA C" are meaningful specifications; "TEMA" alone is not.*

* This material and all other set in similar size type is from TEMA Standards, fourth edition, 1959.

Size. The new standards contain a definition of nominal size which never existed before. The combination of size and type designation now permits an engineer to specify a unit in great detail with a very minimum statement. For example, "Size 23-192 Type AES" now indicates a "split ring floating head exchanger with removable channel and cover, single pass shell, 23¼-inch inside diameter with tubes 16 feet long."

In the past there has been much confusion between engineers, manufacturers of equipment, users of equipment, etc. in regard to the proper designation of the unit. Very often confusion would exist between the removable channel (Type A), the bonnet (Type B), and the integral channel (Type C).

Tube length has been designated by some engineers in feet and by others in inches.

At last there is a common standard. The new size numbering and type designations represent a tremendous advance for all those interested in heat exchanger equipment.

N-2.11 Nominal Diameter shall be the inside diameter of the shell in inches, rounded off to the nearest integer. For kettle reboilers the nominal diameter shall be the port diameter followed by the shell diameter, each rounded off to the nearest integer.

N-2.12 Nominal Length shall be the tube length in inches. Tube length for straight tubes shall be taken as the actual over-all length. For U-tubes the length shall be taken as the straight length from end of tube to bend tangent.

N-2.2 Type designation shall be by letters describing stationary head, shell (omitted for bundles only), and rear head, in that order, as indicated in Figure N-2.2.

N-2.3 Typical Examples.

N-2.31 Split-ring floating head exchanger with removable channel and cover, single pass shell, 23¼-inch inside diameter with tubes 16-feet long. SIZE 23-192 TYPE AES.

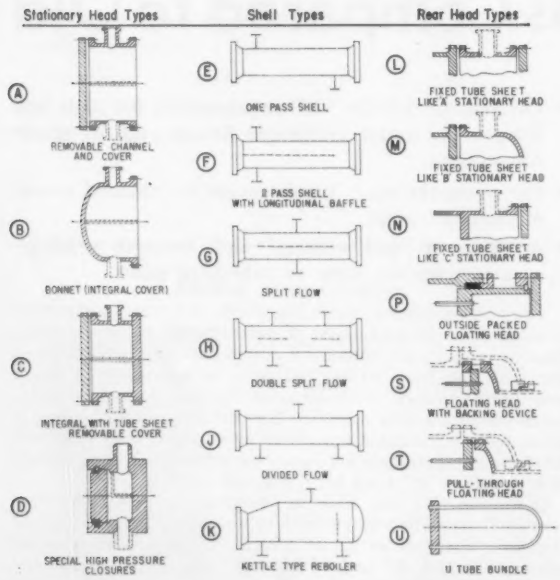

FIGURE N-2.2—This nomenclature is used in the new numbering system.

N-2.32 U-Tube exchanger with bonnet type stationary head, split flow shell, 19-inch inside diameter with tubes 7-feet straight length. SIZE 19-84 TYPE BGU.

N-2.33 Pull-through floating head kettle type reboiler having stationary head integral with tube sheet, 23-inch port diameter and 37-inch inside shell diameter with tubes 16-feet long. SIZE 23/37-192 TYPE CKT.

N-2.34 Fixed tube sheet exchanger with removable channel and cover, bonnet type rear head, two pass shell, 33⅛-inch diameter with tubes 8-feet long. SIZE 33-96 TYPE AFM.

N-2.35 Fixed tube sheet exchanger having stationary and rear heads integral with tube sheets, single pass shell, 17-inch inside diameter with tubes 16-feet long. SIZE 17-192 TYPE CEN.

Some changes in tolerances for external and internal dimensions have been incorporated. Among these changes are:

- Length of heat exchanger shell tolerances changed from ± ⅛ inch to ± ¼ inch.
- Tolerance between face to face of channel nozzles was ± ⅛ inch. Tolerance for all nozzle faces is ± ⅛ inch from the exchanger centerline.
- Alignment tolerance for nozzles increased.

The exchanger specification sheet no longer indicates the thicknesses of parts nor clean transfer rate. Both gross surface and effective surface now appear. Fouling resistance has been added.

Many users of TEMA heat exchangers expect to receive complete drawings with all shop details. The new standards indicate (by omission) that these drawings are not normally made available to the customer. Furthermore, Paragraph G-4.3 restricts the customer from making prints available to others without the manufacturer's permission.

G-4.1 Drawings For Approval And Change. The manufacturer shall submit for purchaser's approval three prints of an *outline drawing* showing nozzle sizes and locations, overall dimensions and supports. It is anticipated that a reasonable number of minor drawing changes may be required at that time. Changes subsequent to receipt of approval may cause additional engineering expense chargeable to the purchaser.

G-4.2 Drawings For Record. After approval of drawings the manufacturer shall furnish without extra charge 6 prints or, at his option, a reproducible copy of the final outline drawing and all gasket drawings.

G-4.3 Proprietary Rights To Drawings. The drawings and the design indicated by them are to be considered the property of the manufacturer and are not to be used or reproduced without his permission.

Guarantees. The new performance guarantee does not warrant defects in heat exchanger design as did the third edition and limits the manufacturer's responsibility "only to the extent of the original manufacturer's warranty to the heat exchanger fabricator". Another major change is a paragraph on "Consequential Damage".

G-5.1 Performance. The manufacturer shall guarantee the performance of the heat exchanger for a period of one year from shipping date when operated under design conditions

specified, but shall assume no responsibility for excessive fouling of the apparatus by material such as coke, silt, scale or any foreign substance that may be deposited. The specified design conditions are those shown on the exchanger specification sheet G-5.1 furnished by the manufacturer.

G-5.2 Material And Workmanship. The manufacturer shall warrant each heat exchanger against defects of material and workmanship for a period of one year from shipping date and shall repair or replace f.o.b. his plant any parts proven defective within said period. *Finished materials and accessories purchased from other manufacturers,* including metal tubing, *are warranted only to the extent of the original manufacturer's warranty* to the heat exchanger fabricator.

G-5.3 Consequential Damage. *The manufacturer shall not be held liable for any indirect or consequential damage.*

G-5.4 Corrosion. The manufacturer assumes no responsibility for deterioration of any part or parts of the equipment due to corrosion, erosion, or any other causes, regardless of when such deterioration occurs after leaving the manufacturer's premises.

E-1.1 Performance Failures. The failure of heat exchanger equipment to perform satisfactorily may be caused by one or more of the following factors:

1. Excessive fouling.
2. Air or gas binding resulting from improper piping, or lack of suitable vents.
3. Operating conditions differing from design conditions.
4. Maldistribution of flow in the unit.
5. Excessive clearances between the baffles and shell and/or tubes, due to corrosion.
6. Improper thermal design.

The user's best assurance of satisfactory performance lies in dependence upon manufacturers of established competence in the design and fabrication of heat transfer equipment.

Operation of Heat Exchangers now states "Do not operate equipment under conditions in excess of those specified on the name plate." Draining the unit is more fully described. Bolted joints are discussed. . . .

". . . all external bolted joints should be properly retightened after installation and again after the exchanger has been heated, to prevent leaks and blowing out of gaskets."

Some users of heat exchanger equipment do not have complete company specifications and established practices. The TEMA Standards, as revised, make certain information available to equipment users. Occasionally the blame for unsatisfactory gaskets has been placed upon the exchanger manufacturer. The revised paragraph on gasket replacement alerts the customer to certain basic requirements.

E-4.5 Gasket Replacement. Gaskets and gasket surfaces should be thoroughly cleaned and should be free of scratches and other defects. Gaskets should be properly positioned before attempting to retighten bolts. It is recommended that, when a heat exchanger is dismantled for any cause, it be reassembled with new gaskets. This will tend to prevent future leaks and/or damage to the gasket seating surfaces of the heat exchanger. Composition gaskets become dried out and brittle so that they do not always provide an effective seal when reused. Metal or metal jacketed gaskets, when compressed initially, flow to match their contact surfaces. In so doing they are work hardened so, if reused, they may provide an imperfect seal or result in deformation and damage to the gasket contact surfaces of the exchanger.

A most important paragraph, which has not been changed from the previous edition, concerns the relationship between TEMA and the American Society of Mechanical Engineers.

R-1.12 Construction Codes. The individual vessels shall comply with the ASME Code for Unfired Pressure Vessels, hereinafter referred to as the Code. These standards supplement and define the Code for heat exchanger applications.

Testing. The new standards have revised the test procedure which previously merely required that "the hydrostatic test pressure at room temperature shall be a minimum of 1.5 times the design pressure,

R-1.31 The hydrostatic test pressure at room temperature shall be 1.5 times the design pressure corrected for temperature, except for cast iron parts here other Code requirements govern.

R-1.32 Air or gas is hazardous when used as a pressure testing medium. It is therefore recommended that the following minimum precautions be taken when air or gas testing is specified.

R-1.321 Test Sequence. An air or gas test shall be immediately preceded by a hydrostatic test as required by paragraph R-1.31.

R-1.322 Test Pressure. The test pressure shall not exceed one half the design pressure, or 100 psi, whichever is smaller.

R-1.323 Leak Detection. Leaks may be located by halide probe, or by other means, as agreed upon between the purchaser and the manufacturer.

Design temperatures may be fixed by the use of engineering judgment for the various components. Tubesheets and internal floating head covers need not be designed for the higher of the shell and tube side design temperatures. Internal floating head cover bolting design should consider the operating temperature on the shell side as well as on the tube side.

R-1.42 Design Temperature Of Heat Exchanger Parts. The design temperature of heat exchanger parts subject to two different fluid temperatures shall be the maximum metal temperature of the part under operating conditions. In establishing the metal temperatures, due consideration shall be given to such factors as the relative heat transfer coefficients of the two fluids contacting the part and the relative heat transfer areas of the parts contacted by the two fluids.

Corrosion Allowance. The word "approximately" no longer appears in paragraphs R-1.511 and C-1.511. Since a flange corroded on its gasket surface is no longer servicable the new paragraphs R-1.515 and C-1.515 state: "**End Flanges.** Corrosion allowance shall be applied only to the inside diameter of flanges."

"**R-1.52 Alloy Parts.** No corrosion allowances is to be added to alloy parts except as specified by the purchaser." Where all parts in contact with the fluid are of alloy and corrosion allowance is specifically indicated, the allowance is required. Where both carbon steel and alloy parts are in contact with the fluid (eg. steel shell side, alloy tube side) the corrosion allowance indicated by the purchaser applies only to the *steel* parts unless specified otherwise.

Corrosion allowance is now required on cast iron pressure parts.

Tubes. Standard tube lengths are now 8, 10, 12, 16, and 20 feet. Ten and 20-foot lengths have been added to the new standards.

Class "C" now includes ¼", ⅜", and ½" tubes as well as the previously listed sizes of ⅝", ¾", 1", 1¼", and 1½".

Carbon steel, copper and copper alloy, aluminum and aluminum alloy tubes are now *minimum wall*. Other alloys are furnished to *average wall* specifications. The previous edition could be interpreted to require minimum wall tubing at all times.

U-tubes are now discussed in detail and formulas for wall thickness take into account both the expected thinning during bending and the change in stress distribution in a torus as compared with a straight cylinder.

Shells

R-3.11 and C-3.11 Shell Diameters. It shall be left to the discretion of each manufacturer to establish a system of standard shell diameters within the TEMA Mechanical Standards in order to achieve the economies peculiar to his individual design and manufacturing facilities. Nothing in the TEMA Standards shall be construed as a limitation on the minimum or maximum shell diameters.

R-3.121 and C-3.121 Pipe Shells. The inside diameter of pipe shells shall be in accordance with the ASTM pipe specifications.

Minimum Thickness of Shells. The minimum thickness of alloy shells has been added. Steel shell thicknesses for Class "R" are unchanged but a new note now permits significant deviation from tabulated values. "NOTE: Exchangers designed in such fashion that the main shell nozzles are not installed in that section of the shell generally used for close confinement of the baffles may have reasonably lesser thicknesses than those indicated, above, provided the thicknesses used are still in conformance with the Code."

Class "C" steel shell thicknesses have either been maintained or increased slightly.

Baffles and Support Plates. Changes include the requirement that baffle edges be given a workmanlike finish, and "Baffle cuts shall be expressed as the ratio of segment opening height to shell inside diameter." Tube hole size requirement has been clarified.

Clearances between inside of shell and diameter of baffle formerly included different values for liquids and gases. The former have been retained for all cases except "where such clearance has no significant effect on shell side heat transfer coefficient or mean temperature difference, these maximum clearances may be increased to twice the tabulated values."

Differences Between TEMA Class R and TEMA Class C Requirements

Class R

R-1.11 "The TEMA Mechanical Standards for Class R Heat Exchangers specify design, fabrication, and materials of unfired shell and tube heat exchangers for the generally severe requirements of petroleum and chemical processing applications. Equipment fabricated in accordance with these standards is designed for safety and durability under the rigorous service and maintenance conditions in such applications."

R-1.23 "Cast iron shall be used only for water service at pressures not exceedings 150 psi."

R-1.511 ⅛-inch minimum corrosion allowance on carbon steel pressure parts, except tubes.

R-1.53 ⅛-inch corrosion allowance on cast iron pressure parts.

R-2.2 Standard tube diameters and gages are limited to ¾, 1, 1¼, and 1½-inch tubes.

R-2.5 Square pitch tubes must have a minimum cleaning lane of ¼-inch.

R-3.13 Minimum thickness of shells

	Minimum Shell Thickness, Inches		
Shell diameter	Steel pipe	Steel plate	Alloy
8-12	sch. 30	——	1/8
13-29	3/8	3/8	3/16
30-39	——	7/16	1/4
40-60	——	1/2	5/16

Class C

C-1.11 "The TEMA Standards for Class C Heat Exchangers specify design, fabrication, and materials of unfired shell and tube heat exchangers for the generally moderate requirements of commercial and general process applications. Equipment fabricated in accordance with these standards is designed for the maximum economy and over-all compactness consistent with safety and service requirements in such applications."

C-1.23 "Cast iron shall not be used for pressures exceeding 150 psi, nor for lethal or flammable fluids at any pressure."

C-1.511 1/16-inch minimum corrosion allowance on carbon steel pressure parts, except tubes.

C-1.53 1/16-inch corrosion allowance on cast iron pressure parts.

C-2.2 Tube diameters and gages. For ¾ through 1½-inch tubes data is the same as for Class R. ¼, ⅜, ½, and ⅝-inch tube data are also shown.

C-2.5 For tubes on a square pitch in shells 12 inches in diameter and less a minimum cleaning lane of 3/16-inch is permitted.

C-3.13 Minimum thickness of shells, inches.

Shell diameter	Steel Pipe	Steel Plate	Alloy
6	sch. 40	——	1/8
8-12	sch. 30	——	1/8
13-23	sch. 20	5/16	1/8
24-29	——	5/16	3/16
30-39	——	3/8	1/4
40-60	——	7/16	1/4

Baffle and support plate thickness requirements are clarified. The maximum spacings were 60 tube diameters for one inch OD and larger tubes, 52 inches for ¾-inch tubes, and 42 inches for ⅝-inch tubes and have been significantly changed. The new standards have different unsupported lengths for all the standard tube sizes. One set of limitations applies to steels, nickel, nickel-copper, and nickel-chromium-iron, and another set is applicable for aluminum, copper and alloys of each.

Impingement baffles were required in practically all units except thermosyphon reboilers. Impingement baffle requirements are now set by density and velocity for non-abrasive, single-phase fluids. Consideration for nozzle exit area in vaporizers is now required.

Tie rod combinations may now be varied as long as the equivalent metal area is maintained.

Minimum cross over requirements for floating heads, channels and bonnets are added. Specifications for packed floating heads and nozzle stuffing boxes have been incorporated into the new edition.

Gasket requirements now offer a choice of confined and unconfined gasket joints for Class C exchangers (confined joints are still required for Class R). Three-eighths inch wide gaskets may now be used through the 25 inch shell size, where 23 inch was the previous limit.

Effective tubesheet thickness has been redefined as "the thickness measured at the bottom of the pass partition groove minus shell side corrosion allowance and corrosion allowance on the tube side in excess of the groove depth." Paragraphs on applied and clad tubesheet facings have been added. A nominal ⅛ inch facing material beneath the bottom of pass partition grooves in tubesheets and channel covers is now mandatory.

The "F" factor for fixed tubesheet construction in the tubesheet thickness formula has been significantly changed. The previous edition did permit the use of factors as low as 0.3 to 0.4, when the shell side pressure was governing. The new edition presents a factor of 0.80 when the wall thickness-ID ratio for integral vessels exceeds 0.05. This factor "shall apply whenever the sta-

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R-4.41 Transverse baffle and support plate thicknesses are shown.

C-4.41 Transverse baffles and support plates. Data is the same as for Class R except as noted. For the distance between adjacent segmental plates of 12 inches and less the thicknesses in some instances are less. Data for 6-inch nominal diameter shells are included.

R-4.42 Longitudinal baffles shall have a minimum total metal thickness of ¼-inch.

C-4.42 Longitudinal alloy baffles shall have a minimum total metal thickness of ⅛-inch.

R-4.52 Maximum unsupported straight tube length for ¾, 1, 1¼ and 1½-inch tubes.

C-4.52 Same as TEMA R except that ¼, ⅜, ½, and ⅝-inch unsupported lengths added.

R-4.61 "For services involving non-corrosive, non-abrasive, single phase fluids having entrance line values of ρV^2 less than 500, protection against impingement may not be required. In this, V is the linear velocity of the fluid in feet per second, and ρ is its density in pounds per cubic foot. In all other cases means shall be provided to protect the tube bundle entrance against impinging fluids."

C-4.61 Same as Class R except ρV^2 less than 1,500. does not require impingement protection.

R-4.71 Number and size of Tie Rods.

C-4.71 Number and size of tie rods are the same as Class R except that ¼-inch rod may be used in 6- to 15-inch shells rather than the ⅜-inch required for 8- to 15-inch shells of Class R.

R-5.1 Cross-over area for multipass floating heads "is at least equal to 1.3 times the flow area through the tubes of one pass."

C-5.1 1.3 factor is replaced by 1.00 for cross-over area.

R-5.2 Fabricated steel floating covers shall be stress relieved after completion of all welding.

C-5.2 Fabricated floating heads need not be stress relieved unless required by ASME Code.

R-5.6 Packed floating head and nozzle stuffing boxes. Dimensional data 8 inches through 23 inches.

C-5.6 Packed floating head and nozzle stuffing boxes. Same data as for Class R except that 6-inch shell size is included.

R-6.2 "Metal jacketed or solid metal gaskets shall be used for all joints for pressures of 300 psi and over, and for all joints in contact with oil or oil vapor."

C-6.2 "For design pressures of 300 psi and lower, asbestos composition gaskets may be used for external joints, unless temperature or corrosive nature of contained fluid indicates otherwise. Metal jacketed or filled gaskets or solid metal gaskets shall be used for all joints for design pressures greater than 300 psi."

R-6.4 "The width of gasket web for pass ribs of channels and floating heads shall not be less than ⅜-inch."

C-6.4 Minimum gasket width of ¼-inch is permitted.

R-6.6 "Gasketed joints shall be of the confined type . . ."

C-6.6 Gasketed joints may be of the confined or unconfined type.

tionary tubesheet is integral with the adjoining pressure part under consideration" and thus is applicable to the floating tubesheet of outside packed head exchangers.

Requirements for fixed tubesheet exchangers with expansion joints have been changed. A paragraph on double tubesheet construction has been added.

C-7.151 Exchangers with Shell Expansion Joints. The thickness of the tubesheets in exchangers with shell expansion joints shall be calculated as for floating tubesheet exchangers, considering tube side design conditions only. See paragraph C-7.19, however, for limitations on the definition of "expansion joint."

C-7.152 Exchangers Without Shell Expansion Joints. Fixed tubesheet exchangers without shell expansion joints are adequate under certain conditions of moderate differential expansion between shell and tubes. Due to the complex interrelation between tubesheet, tubes, shell, and channel, the governing stress condition in such exchangers may occur in any one of these components. In view of this complexity, it does not appear practical to publish fixed tubesheet design equations of broad applicability in this edition of the Standards. Study continues, however, with the object of early publication as Addenda. It may be stated that generally recognized design principles are set forth in the following references:

"Heat Exchanger Tube Sheet Design," by K. A. Gardner, Trans. ASME., Vol. 70, pp. A-377-385, 1948.

"Heat Exchanger Tube Sheet Design—2. Fixed Tube Sheets," by K. A. Gardner, Trans. ASME., vol. 74, pp. A-159-166, 1952.

"Design of Tube Plates in Heat Exchangers," by K. A. G. Miller, Proc. Inst. Mech. Engrs., Series B, vol. 1, pp. 215-231, 1952.

R-7.182 Vents and Drains. Double tubesheets of the edge welded type shall be provided with vent and drain connections at the high and low points of the enclosed space.

The diameters and tolerances of tubeholes in tubesheets have been modified. A maximum over tolerance has been added. Tubesheet drilling tolerances are also modified. The minimum standard ligament is based on a ligament tolerance not exceeding the sum of twice the drill drift tolerance plus 0.030 inch for Class R. Drill drift tolerance equals 0.0016 inch x (Thickness of tubesheet)/(Tube diameter). (Note: For tubes smaller than ⅝ inch, Class "C" substitutes 0.020 inch for the 0.030 inch).

Tubehole finish and grooving requirements are clarified.

R-7.121 Minimum thickness of tube sheet equals outside tube diameter plus the corrosion allowances on both sides of the tube sheet.

C-7.121 Minimum thickness of tube sheet equals corrosion allowances on both sides of the tube sheet plus factor.

Tube OD	Factor
1-inch or less	0.75 x tube OD
1¼-inch	⅞-inch
1½-inch	1-inch

R-7.21 Diameters and tolerances for ¾, 1, 1¼, 1½-inch tubeholes in tubesheets on standard and close fit.

C-7.21 Same as TEMA R except ¼, ⅜, ½, and ¾-inch tube hole data added.

R-7.22 Tubesheet drilling tolerances. Data for ¾, 1, 1¼, and 1½-inch tubes are shown.

C-7.22 Tube sheet drilling tolerances are the same as for Class R in sizes ¾-inch and up. Tolerances for ¼, ⅜, ½, and ⅝-inch tubes are also shown.

R-7.23 "The inside edges of tube holes in tubesheets shall be chamfered to prevent cutting of the tubes. Internal surfaces shall be given a workmanlike finish."

C-7.23 "Chamfered" is replaced by "deburred."

R-7.24 "All tubesheet holes for expanded joints shall be machined with at least two grooves, each approximately ⅛-inch wide by 1/64-inch deep."

C-7.24 "For design pressures of 300 psi and/or temperatures in excess of 350° F, the tube holes for expanded joints in tubes ⅝-inch OD and larger shall be machined with at least two grooves, each approximately ⅛-inch wide by 1/64-inch deep."

R-7.31 "Tubes shall be expanded into the tubesheet for a length no less than 2 inches, or tubesheet thickness minus ⅛-inch, whichever is smaller."

C-7.31 "Tubes shall be expanded into the tube sheet for a length no less than two tube diameters (for ¾-inch OD tubes and smaller, this is less than two inches), two-inch or tube sheet thickness minus ⅛-inch, whichever is smallest."

R-7.5 "All tubesheets shall be provided with approximately 3/16-inch deep grooves for pass partitions.

C-7.5 "For design pressures of 300 psi and higher, tube sheets shall be provided with pass partition grooves approximately 3/16-inch deep, or other suitable means for retaining gaskets in place."

R-8.11 "The minimum thickness, including corrosion allowance of channels or bonnet type heads is to be in accordance with minimum shell thicknesses shown in Table R-3.13."

C-8.11 Table "R-3.13" is replaced by "C-3.13."

R-8.12 "For multiple (pass) channels the inside depth shall be such that the minimum cross-over area for flow between successive tube passes is at least equal to 1.3 times the flow area through the tubes of one pass."

C-8.12 "Equal to 1.3 times the flow area" is replaced by "equal to the flow areas."

R-8.14 "Fabricated and/or forged steel channels shall be stress relieved after all welding."

C-8.14 Fabricated channels need not be stress relieved unless required by ASME Code.

Expanded tube to tubesheet joints are now defined as standard. Length of tube expansion in the tubesheet is now defined. It is *not* necessary to expand for the full depth of the tubesheet as has been the customary practice in some segments of the industry. A smooth contour at the end of the expanded portion of the tube is now required.

C-7.6 Tubesheet Pulling Eyes. In exchangers with removable tube bundles having a nominal diameter exceeding 12 inches and/or a tube length exceeding 96 inches, the stationary tubesheet shall be provided with two tapped holes in its face for pulling eyes. These holes shall be protected in service by plugs. Provision for pulling means may have to be modified or waived for special constructions, such as clad tubesheets or manufacturer's standard, by agreement between manufacturer and purchaser.

Pass partition plate thickness for alloy material is ⅜ inch. A somewhat different requirement previously appeared for Class "A" of the third edition.

The thickness of channel covers for multipass units has been increased by deleting the previous "multipliers" and substituting the formula shown below.

R-8.21 Effective Channel Cover Thickness. The effective thickness of flat channel covers shall be the thickness measured at the bottom of the pass partition groove minus tube side corrosion allowance in excess of the groove depth. The required value shall be either that determined from the appropriate Code formula or from the following equation, whichever is greater:

$$T = \left[5.7P \left(\frac{G}{100} \right)^4 + 2 \frac{h_G A_b}{\sqrt{d_B}} \left(\frac{G}{100} \right) \right]^{1/3}$$

where T — Effective channel cover thickness, inches.
P — Design pressure, psi.
G — Mean gasket diameter, inches.
d_B — Nominal bolt diameter, inches.
h_G — Radial distance between mean gasket diameter and bolt circle, inches.
A_B — Actual total cross-sectional area of bolts, square inches.

Note: For high alloy steels and non-ferrous metals, and for carbon steel at higher temperatures, the value obtained from this formula shall be multiplied by $(25{,}000{,}000/E)^{1/3}$, where E is the elastic modulus of the cover material at the design temperature (This sentence has been added in an addenda to the fourth edition).

R-8.22 "All channel covers shall be provided with approximately 3/16-inch grooves for pass partitions."

C-8.22 "For design pressures of 300 psi and higher, channel covers shall be provided with approximately 3/16-inch deep grooves for pass partitions, or other suitable means for holding the gasket in place."

R-9.3 "All pipe tap connections shall be a minimum of 3,000 psi standard couplings or equivalent. Each connection shall be fitted with a plug, approximately 3-inches long, of the same material as the connection to which plug is attached."

C-9.3 Plugs are not required for pipe tap connections.

R-9.32 "All flanged nozzles 1½ inches or larger shall be provided with one horizontal connection of ½-inch minimum size for a pressure gage . . ."

C-9.32 "Pressure connections shall be as specified by the purchaser."

R-9.33 "All flange nozzles 3-inch size or larger shall be provided with one ¾-inch horizontal connection for a thermometer unless special considerations require it to be omitted. See Para. R-9.4."

C-9.33 "Thermometer connections shall be as specified by the purchaser."

R-10.1 "The minimum permissible bolt diameter shall be ¾-inch. Threads shall be in accordance with ASA No. B1.1 for high strength bolting. Sizes 1-inch and smaller shall be Coarse Thread Series and larger sizes shall be 8-Pitch Thread Series."

C-10.1 "The minimum permissible bolt diameter shall be ½-inch for exchangers with a nominal shell diameter of 12 inches or less, and ⅝-inch for all other sizes."

R-10.22 "The maximum spacing between bolt centers shall be

$$B_{max} = 2d_B + \frac{6t}{(m + 0.5)}$$

Where B = bolt spacing, inches
d_B = nominal bolt diameter, inches
t = flange thickness, inches
m = gasket factor used in Code flange calculations."

C-10.22 "The maximum spacing between bolt centers shall be

$$B_{max} = 2d_B + \frac{6t}{(m - 0.5)}$$

R-10.3 Minimum wrench and nut clearances, for ¾ through 2-inch bolts in ⅛-inch increments are shown.

C-10.3 Minimum wrench and nut clearances are the same as for Class R except that data for ½ and ⅝-inch bolts are also shown.

R-10.4 Load concentration factor for flange design is shown.

C-10.4 (An apparent typographical error does not list this paragraph but) "$\sqrt{(2d_B + t)}$" is replaced by "$\sqrt{(2d_B + 2.5t)}$" and "$\sqrt{B/(2d_B + t)}$" is replaced by "$\sqrt{B/(2d_B + 2.5t)}$."

For single-pass channels, or others in which there is no pass partition gasket seal against the channel cover, only the Code formula need be considered.

Nozzle requirements have been significantly changed. TEMA Class "R" previously required welding neck type nozzles or welding neck flanges and extra heavy pipe. Any nozzle complying with ASME Code requirements is now acceptable. "Channel nozzles may (now) protrude inside the channel provided vent and drain connections are flush with the inside contour of the channel." Radial nozzles remain as standard. However, "other types of nozzles may be used, by agreement between manufacturer and purchaser."

Vent and drain requirements are modified so that pipe taps in nozzles may serve for these functions. "Pressure gage and thermometer connections may (now) be omitted in one of two mating connections of (stacked) units connected in series."

Split flange design for nozzles is now covered by a new paragraph.

The high hub flanges previously required for Class "R" are no longer required. The standard flange dimensions have been deleted from the new edition of the TEMA Standards. Requirements for bolt spacing, wrench and nut clearances, and load concentration factor in flange design have been added.

Material specifications have been revised but still include the statement that "Materials listed are to be considered as the minimum qualities of their kinds and such specifications do not exclude the use of any material of an equivalent or superior quality." Spacer requirement has been modified to permit the use of "any tubular material of commercial quality equivalent in corrosion resistance to baffle or tube material."

The **Thermal Standards** have had several modifications. A wall resistance formula for circumferentially finned tubes has been added. Fouling factor requirements have been clarified. Some of the new designations include: hydraulic fluid, molten heat transfer salts, industrial organic heat transfer media, liquified petroleum gases, etc. Figures for the "thermal effectiveness counterflow exchangers" have been added. Pressure drop and heat transfer curves and equations have been deleted. Different viscosity-temperature curves for petroleum liquids are shown. High pressure gas viscosity is now presented and thermal conductivities of gases and vapors appear in a new and useful form. Some viscosity, thermal conductivity and physical property data are unchanged.

General Design Data have been updated and increased in scope. Some of the significant changes include:

Table D-4—Length of alloy steel bolt studs for ASA flanges.

Table D-5—Bolting data.

Table D-7—Latest pressure temperature ratings of ASA flanges.

Table D-11—Internal and (external) working pressures for tubing at ten different allowable stress values.

Table D-12—Modulus of elasticity for various metals from 70° F to 1,200° F.

Table D-13—Mean coefficients of thermal expansion for various metals from minus 200° F to plus 1,400° F.

Table D-14—Thermal conductivity of metals from 200° F to 1,500° F.

Key Words for Indexing

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Fabrication
Purchasing
Exchangers
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Stainless Steel
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Tapping
Thermometers

See "New Information Retrieval Standards," PETROLEUM REFINER, May 1961, p263.

About the Author

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Rubin

Try this method . . .

Graphs Cut Exchanger Design Time

If you know the maximum allowable pressure drop on the shell and tube sides and the heat duty in Btu/hr, you can determine the minimum exchanger required

J. Starczewski
Constructors John Brown, Ltd., London

Normally the maximum allowable pressure drop (ΔP) on shell and tube sides and the heat duty (Btu/hr) are known. The problem is to find the minimum size of heat exchanger that would be suitable for this specified duty and ΔP. When designing heat exchangers by calculations one assumes heat exchanger size, baffle pitch and number of shell and tube passes. Then R_e, P_r, A_s, ΔP and heat transfer on shell and tube sides are calculated and compared with the specified ΔP and heat transfer. This process is repeated until the optimum heat exchanger is reached. The method is laborious and time-consuming. The time-saving graphical method described applies to gases and liquids under viscous or turbulent flow conditions, when there is no phase change. Baffle pitch should be be-

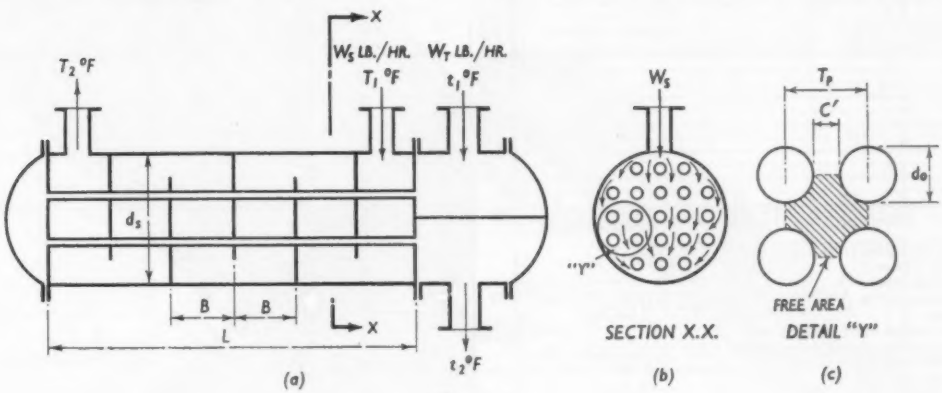


Figure 1

NOMENCLATURE (See Figure 1)

De — Shell equivalent diameter in feet.*

$$De = 4\frac{\text{free area}}{\text{wetted perimeter}}, \text{ for the above case}$$

$$= 4\frac{[T_p^2 - \pi d_o^2/4]}{4[\pi d_o/4]}\frac{1}{12} \text{ ft.}$$

A_s — Shell-side cross flow area in feet²*

$$\left(= \frac{d_s C^1 B}{T_p N_s}\frac{1}{144}\right)$$

C^1 — Tube clearance in inches.
T_p — Tube pitch in inches.
B — Baffle pitch in inches.
L — Tube length in feet.
d_s — Exchanger inside diameter in inches.
$(N + 1)$ — Number of passes between baffles.
A_1 — Heat flow area per foot of tube length in feet².
C_T — Inverse of tube flow area per tube pass in feet^{-2}.
k_o — C_T correction factor.
D — Tube ID in feet.
R_T — Inverse of tube ID in feet^{-1}.
W_s — Fluid flow in pounds per hour.
G — Mass velocity in pounds per hour foot².
μ — Viscosity in centipoises.
c — Specific heat in Btu per pound, °F.
γ — Specific gravity.
ϱ — Density, pounds per foot².
k — Thermal conductivity in $\frac{\text{Btu}}{\text{hours feet}^2}\frac{\text{feet}}{^\circ\text{F}}$
Q — Heat load in Btu per hour.
U — Over-all heat transfer coefficient in $\frac{\text{Btu}}{\text{hours feet}^2}$ °F.
S — Resistance to heat flow in $\frac{\text{hours feet}^2\ ^\circ\text{F.}}{\text{Btu}}$
h — Individual heat transfer coefficient between fluid and surface in $\frac{\text{Btu}}{\text{hours feet}^2\ ^\circ\text{F.}}$
ΔT — Logarithmic-mean over-all temperature difference.
E — Temperature correction factor for multi-pass heat exchanger.
s — Prefix, indicates shell-side.
t — Prefix, indicates tube-side.
Nu — Nusselt number.
Pr — Prandtl number.
Re — Reynolds number.

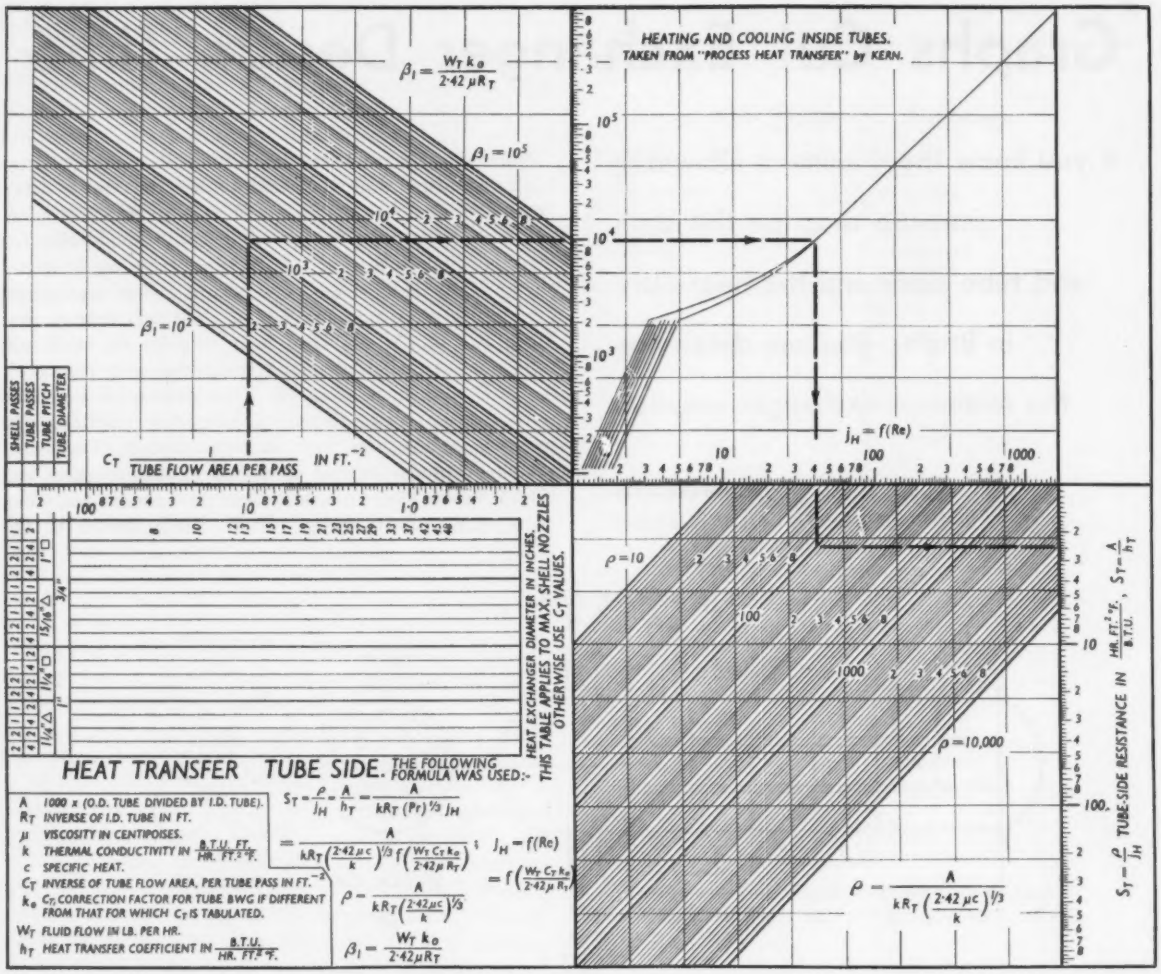

HEATING AND COOLING INSIDE TUBES.
TAKEN FROM "PROCESS HEAT TRANSFER" by KERN.
$\beta_1 = \frac{W_T k_\theta}{2{\cdot}42\,\mu R_T}$
$\beta_1 = 10^5$
$\beta_1 = 10^4$
$\beta_1 = 10^3$
$\beta_1 = 10^2$
$j_H = f(Re)$
C_T $\frac{1}{\text{TUBE FLOW AREA PER PASS}}$ IN FT.$^{-2}$
SHELL PASSES
TUBE PASSES
TUBE PITCH
TUBE DIAMETER
HEAT EXCHANGER DIAMETER IN INCHES.
THIS TABLE APPLIES TO MAX. SHELL NOZZLES OTHERWISE USE C_T VALUES.
$\rho = 10$
$\rho = 100$
$\rho = 1000$
$\rho = 10{,}000$
$\rho = \frac{A}{k R_T \left(\frac{2{\cdot}42\,\mu c}{k}\right)^{1/3}}$
$S_T = \frac{\rho}{j_H}$ TUBE-SIDE RESISTANCE IN $\frac{\text{HR.FT.}^2\text{F.}}{\text{B.T.U.}}$, $S_T = \frac{A}{h_T}$
HEAT TRANSFER TUBE SIDE. THE FOLLOWING FORMULA WAS USED:-
$S_T = \frac{\rho}{j_H} = \frac{A}{h_T} = \frac{A}{k R_T (Pr)^{1/3} j_H}$
$= \frac{A}{k R_T \left(\frac{2{\cdot}42\,\mu c}{k}\right)^{1/3} f\left(\frac{W_T C_T k_\theta}{2{\cdot}42\,\mu R_T}\right)}$; $j_H = f(Re)$
$= f\left(\frac{W_T C_T k_\theta}{2{\cdot}42\,\mu R_T}\right)$
$\rho = \frac{A}{k R_T \left(\frac{2{\cdot}42\,\mu c}{k}\right)^{1/3}}$
$\beta_1 = \frac{W_T k_\theta}{2{\cdot}42\,\mu R_T}$
A 1000 x (O.D. TUBE DIVIDED BY I.D. TUBE).
R_T INVERSE OF I.D. TUBE IN FT.
μ VISCOSITY IN CENTIPOISES.
k THERMAL CONDUCTIVITY IN $\frac{\text{B.T.U. FT.}}{\text{HR. FT.}^2\text{F.}}$
c SPECIFIC HEAT.
C_T INVERSE OF TUBE FLOW AREA, PER TUBE PASS IN FT.$^{-2}$
k_θ C_T CORRECTION FACTOR FOR TUBE B.W.G. IF DIFFERENT FROM THAT FOR WHICH C_T IS TABULATED.
W_T FLUID FLOW IN LB. PER HR.
h_T HEAT TRANSFER COEFFICIENT IN $\frac{\text{B.T.U.}}{\text{HR. FT.}^2\text{F.}}$

Figure 2

tween $d_s/5$ and d_s. The correlations hold for 25 percent cut segmental baffles.

FOUR GRAPHS are used in this method, two for pressure drop on shell and tube sides and two for heat transfer on shell and tube sides. All possible data of a particular fluid and of heat exchanger dimensions are collected and calculated as a characteristic quantity, which becomes constant for the fluid in question. For any assumed heat exchanger it is quickly seen from the graphs whether the flow arrangement and surface satisfy the heat duty and ΔP requirements. This method takes only a fraction of the time taken by the usual method of calculation.

SHELL-SIDE PRESSURE DROP

The pressure drop is given by:

$$\Delta P_s = \frac{f_s G_s^2 D_s (N+1)}{5.22\ 10^{10} \left(\frac{\mu}{\mu_w}\right)^{0.14}} \frac{1^*}{De\gamma} \text{ psi} \qquad (1)$$

* Defined by "Process Heat Transfer," by Kern.

where

$$\left(\frac{\mu}{\mu_w}\right)$$

is the ratio of the viscosities at the pipe wall temperature and at the calorific temperature; and

$$\left(\frac{\mu}{\mu_w}\right)^{0.14}$$

for many cases can be approximated to unity; also

$$D_s = \frac{d_s}{12};\ (N+1) = \frac{12L}{B} \text{ and } G_s = \frac{W_s}{A_s} = \frac{W_s 144 T_p N_s}{d_s C' B}$$

$$\Delta P_s = f_s \left[\frac{12 \times 144^2 L}{6.26\ 10^{11} De\gamma} \left(\frac{T_p W_s}{C'}\right)^2 \frac{N_s^2}{d_s B^3}\right] \qquad (2)$$

and

$$f_s = f(Re) = f\left(\frac{DeG_s}{2.42\mu}\right) = f\left(\frac{144 De T_p W_s}{2.42 \mu C'} \frac{N_s}{d_s B}\right) \qquad (3)$$

$$\Delta P_s = \left[\frac{12 \times 144^2 L}{6.26 \times 10^{11} De\gamma} \left(\frac{T_p W_s}{C'}\right)^2\right] \frac{N_s^2}{d_s B^3}$$

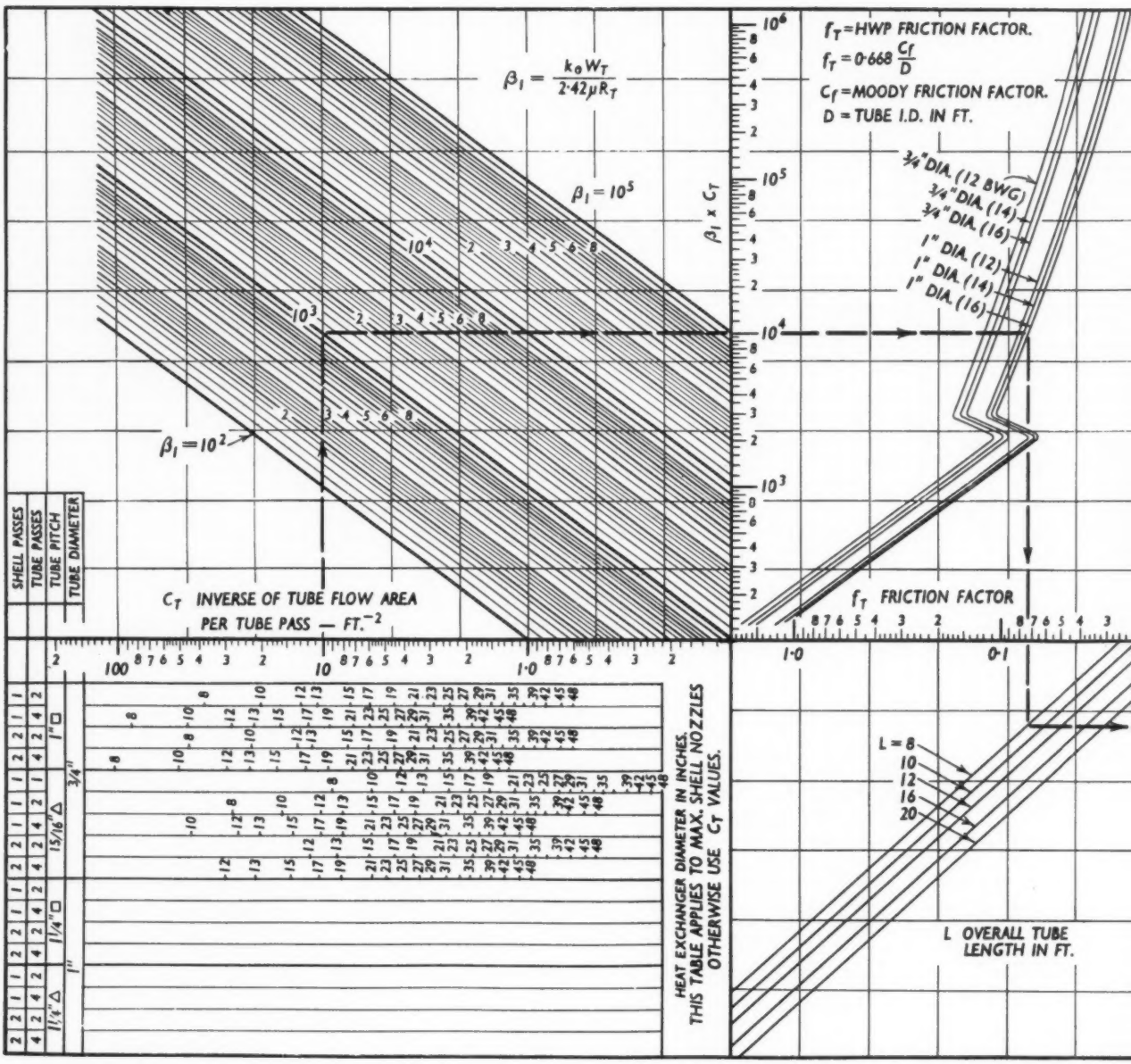


FIGURE 3

$$= \left[3.98\ 10^{-7}\ \frac{L}{De}\ \frac{1}{\gamma}\left(\frac{T_p W_s}{C'}\right)^2\right] \frac{N_s^2}{d_s B^3}\ f\left[\delta_1 \frac{N_s}{d_s B}\right]$$

$$= z_0 \frac{N_s^2}{d_s B^3}\ f\left[\delta_1 \frac{N_s}{d_s B}\right] \text{ pounds per square inch} \qquad (4)$$

For a particular fluid both Z_0 and δ_1 are constant, because, for practical considerations, L, P_T, d_0 are fixed.

In effect we are left with five variables for a general case and with three variables for a particular case.

SHELL SIDE HEAT TRANSFER

For forced fluid flow the following applies:

$$Nu = \alpha Re Pr^{1/3} \left(\frac{\mu}{\mu_w}\right)^{0.14} \qquad (5)$$

and heat transfer factor J_H* is defined as:

$$= \left(\frac{hD}{k}\right)\left(\frac{2.42 \mu c}{k}\right)^{-1/3} \left(\frac{\mu}{\mu_w}\right)^{0.14} \qquad (6)$$

$$\left(\frac{\mu}{\mu_w}\right)^{0.14}$$

is approximated to unity, from (6)

$$h_s = \frac{k}{De}\left(\frac{2.42 \mu c}{k}\right)^{1/3} J_H \qquad (7)$$

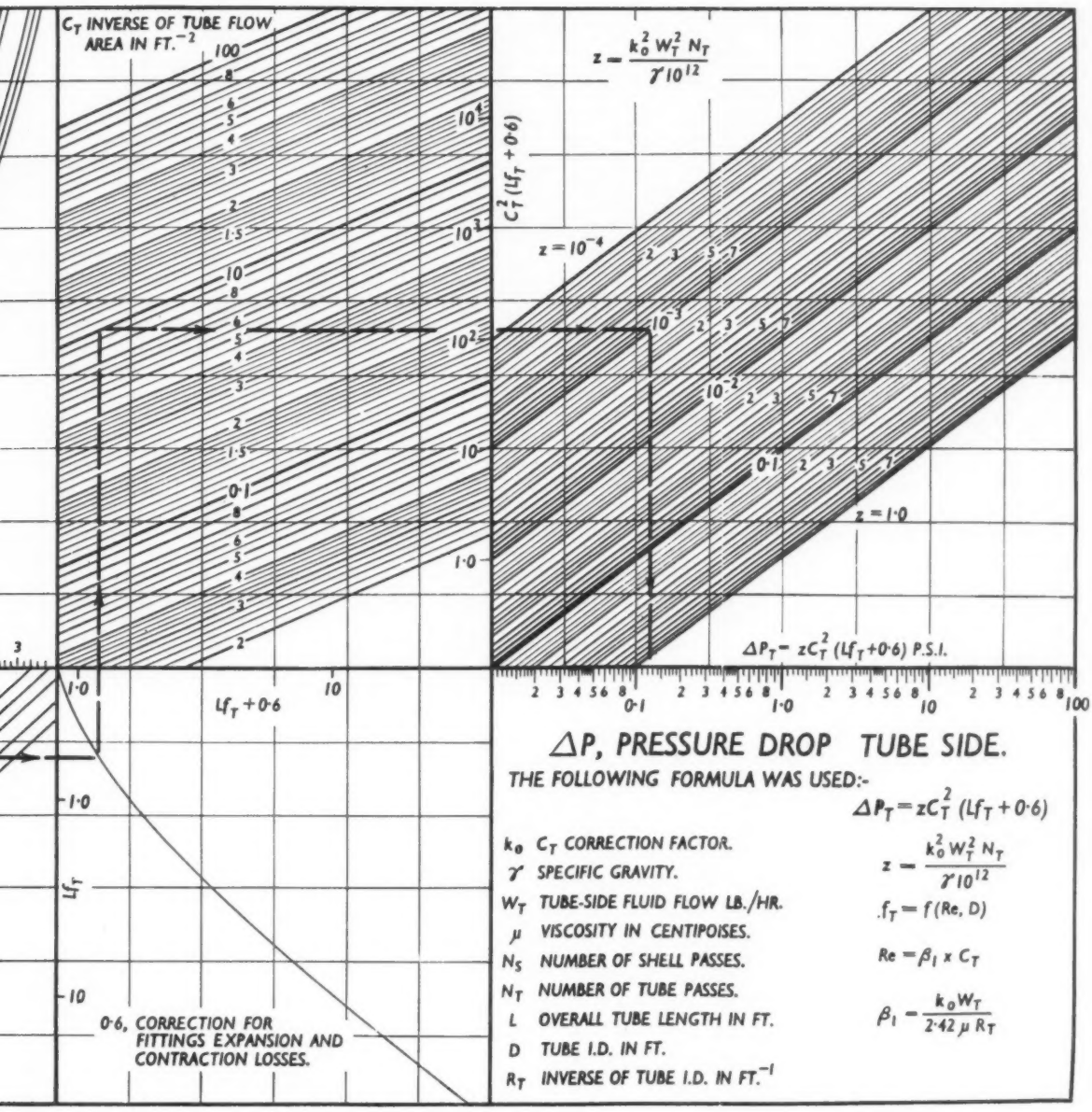
But

from

Res

$S_s =$

where


C_T INVERSE OF TUBE FLOW AREA IN FT.$^{-2}$
$z = \frac{k_o^2 W_T^2 N_T}{\gamma 10^{12}}$
$C_T^2 (Lf_T + 0{\cdot}6)$
$z = 10^{-4}$
$z = 10^{-3}$
$z = 10^{-2}$
$z = 0{\cdot}1$
$z = 1{\cdot}0$
$\Delta P_T = zC_T^2 (Lf_T + 0{\cdot}6)$ P.S.I.
$Lf_T + 0{\cdot}6$
Lf_T
0·6, CORRECTION FOR FITTINGS EXPANSION AND CONTRACTION LOSSES.
ΔP, PRESSURE DROP TUBE SIDE.
THE FOLLOWING FORMULA WAS USED:-
$\Delta P_T = zC_T^2 (Lf_T + 0{\cdot}6)$
k_o C_T CORRECTION FACTOR.
γ SPECIFIC GRAVITY.
W_T TUBE-SIDE FLUID FLOW LB./HR.
μ VISCOSITY IN CENTIPOISES.
N_S NUMBER OF SHELL PASSES.
N_T NUMBER OF TUBE PASSES.
L OVERALL TUBE LENGTH IN FT.
D TUBE I.D. IN FT.
R_T INVERSE OF TUBE I.D. IN FT.$^{-1}$
$z = \frac{k_o^2 W_T^2 N_T}{\gamma 10^{12}}$
$f_T = f(Re, D)$
$Re = \beta_1 \times C_T$
$\beta_1 = \frac{k_o W_T}{2{\cdot}42 \mu R_T}$

3

But

$$J_H = f(Re)$$

From (3) and (4)

$$J_H = f\left(\delta_1 \frac{N_s}{d_s B}\right)$$

Resistance to heat flow S_s is defined by:

$$S_s = \frac{1000}{h_s} = \left(\frac{1000}{\frac{k}{De}\left(\frac{2.42\mu c}{k}\right)^{1/3}}\right) \frac{1}{f\left(\delta_1 \frac{N_s}{d_s B}\right)} = \frac{\rho_1}{f\left(\delta_1 \frac{N_s}{d_s B}\right)} \quad (8)$$

where ρ_1 and δ_1 are constants for a particular fluid.

TUBE SIDE PRESSURE DROP

From Fanning Equation:

$$\Delta F = \frac{4C_f G^2 l}{2g\varrho D} \text{ pounds per square foot per tube pass} \quad (9)$$

G_T is in pounds per hour, therefore,

$$\Delta F = \frac{4C_f G_T^2 L}{64.4 \times 62.4\gamma (3600)^2 D} \frac{1}{144} \text{ pounds per square inch per tube pass}$$

$$= \frac{4C_f G_T^2 L}{7.48\ 10^{12}\gamma D} \text{ pounds per square inch per tube pass.}$$

Assuming that the losses due to expansion, contraction and fittings are equal to:

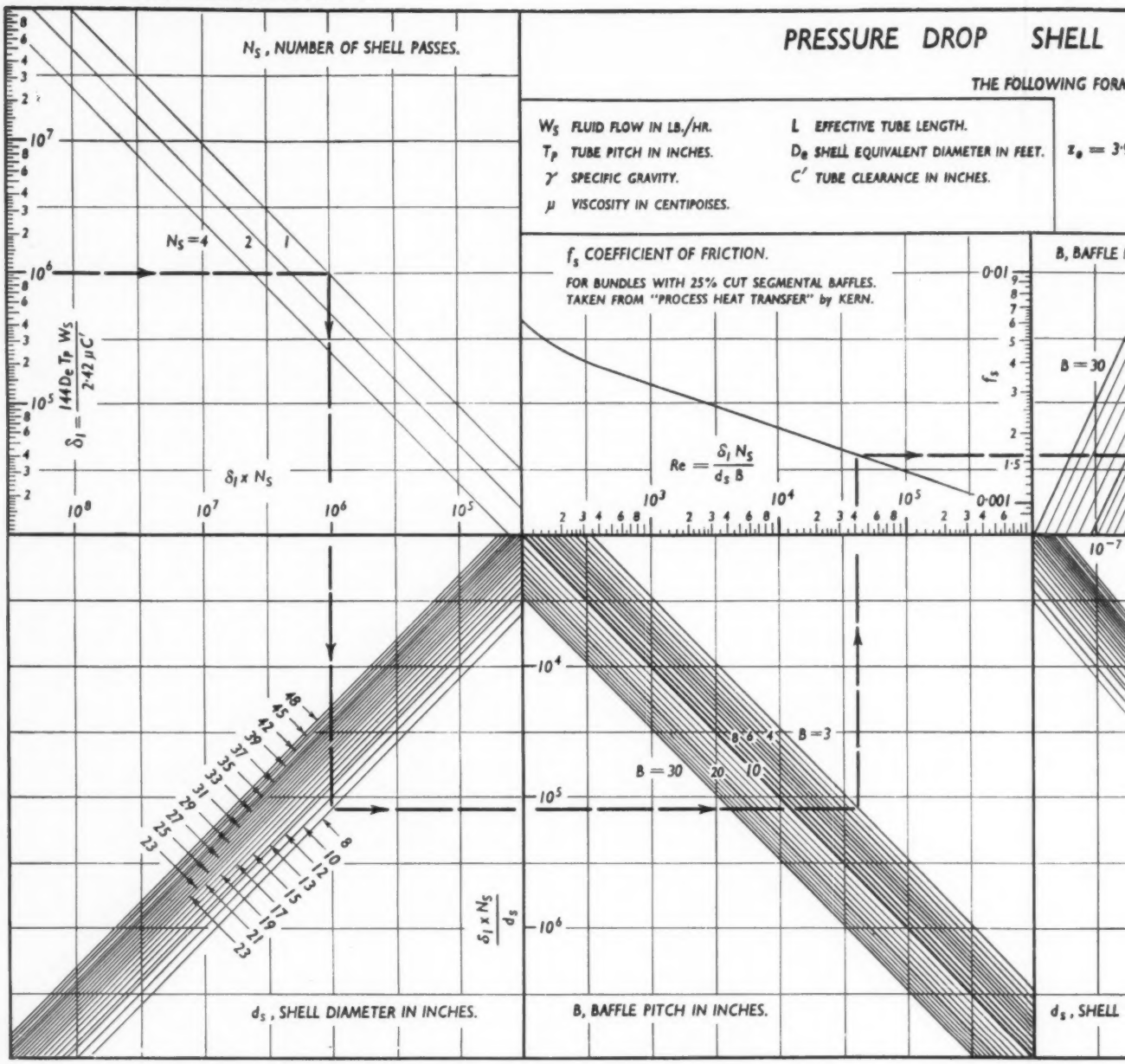

PRESSURE DROP SHELL
THE FOLLOWING FORA
W_S FLUID FLOW IN LB./HR.
T_P TUBE PITCH IN INCHES.
γ SPECIFIC GRAVITY.
μ VISCOSITY IN CENTIPOISES.
L EFFECTIVE TUBE LENGTH.
D_e SHELL EQUIVALENT DIAMETER IN FEET.
C' TUBE CLEARANCE IN INCHES.
N_S, NUMBER OF SHELL PASSES.
$N_S = 4$ 2 1
$\delta_1 = \frac{144 De\ T_P\ W_S}{2{\cdot}42\ \mu C'}$
$\delta_1 \times N_S$
f_s COEFFICIENT OF FRICTION.
FOR BUNDLES WITH 25% CUT SEGMENTAL BAFFLES.
TAKEN FROM "PROCESS HEAT TRANSFER" by KERN.
$Re = \frac{\delta_1 N_S}{d_s B}$
f_s
B, BAFFLE
B = 30
B = 3
$\frac{\delta_1 \times N_S}{d_s}$
d_s, SHELL DIAMETER IN INCHES.
B, BAFFLE PITCH IN INCHES.
d_s, SHELL

FIGURE 4

$$3.5\ \frac{G_T^2}{7.48\ 10^{12}\gamma}\ \text{pounds per square inch per tube pass,}$$

hence, total pressure drop,

$$\Delta P_T = \frac{N_T G_T^2}{7.48\gamma 10^{12}}\left[L\,\frac{4C_f}{D} + 3.5 \right]\ \text{pounds per square inch.}$$

Including a 25 percent safety factor and adopting a new friction factor,

$$f_T = \frac{1.25 \times 4}{7.48}\ \frac{C_f}{D}\ \text{we get:}$$

$$\Delta P_T = \frac{N_T G_T^2}{\gamma 10^{12}}\ [Lf_T + 0.6] \qquad (10)$$

But $f_T = f(Re, D)$ and for a particular tube $f_T = f(Re)$.

$$Re = \frac{G_T}{2.42\mu R_T} = \frac{W_T C_T k_0}{2.42\mu R_T}$$

where $\frac{1}{C_T k_0}$

is a flow area/tube pass.

$$\Delta P_T = \frac{N_T}{\gamma 10^{12}} W_T^2 C_T^2 k_0^2 \left[Lf \left(\frac{W_T C_T k_0}{2.42\mu R_T} \right) + 0.6 \right]$$

$$= zC_T^2\ [Lf\ (\beta_1 \times C_T) + 0.6] \qquad (11)$$

where Z and β_1 are constants for a particular fluid.

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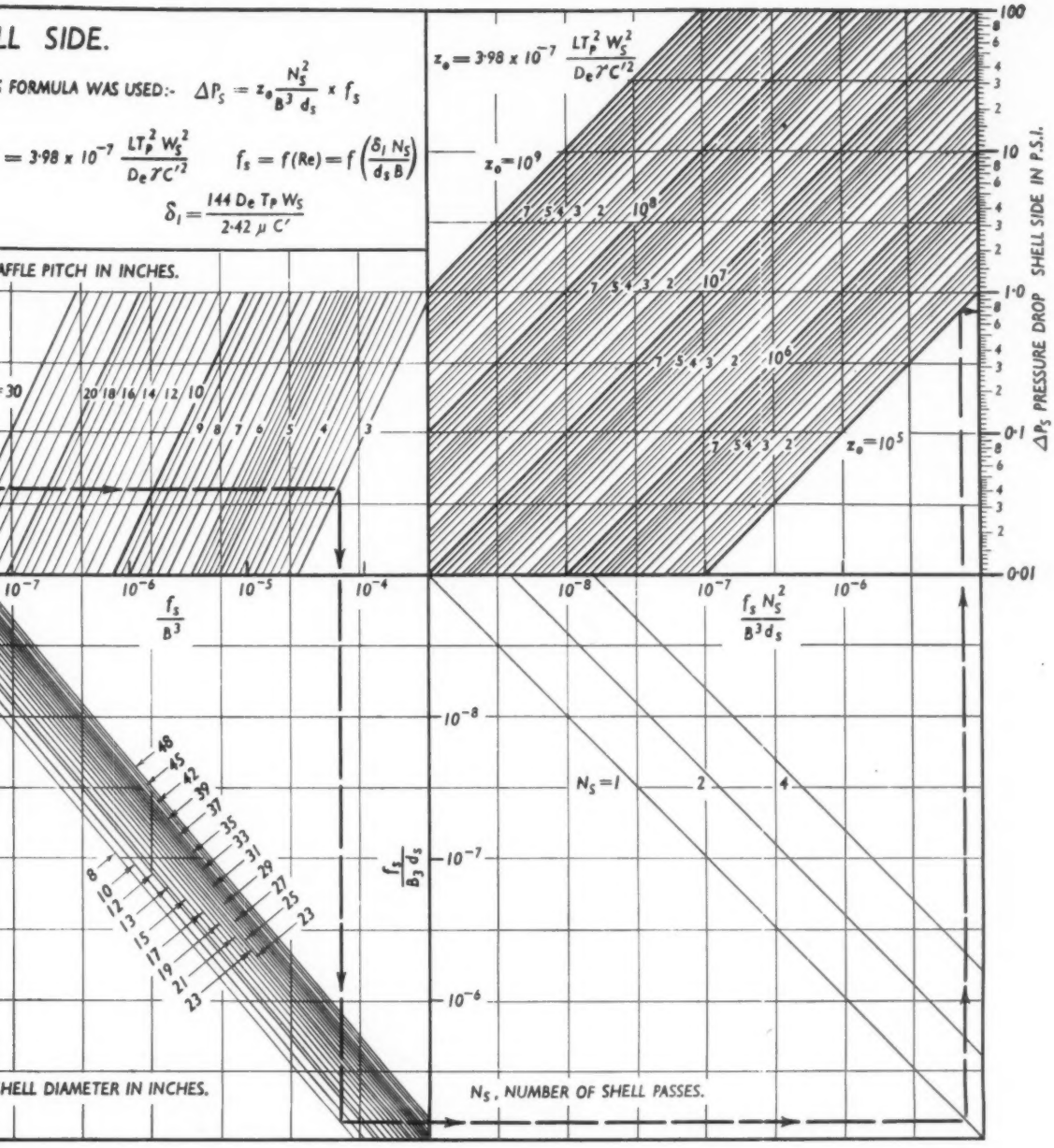
LL SIDE.
FORMULA WAS USED:- $\Delta P_S = z_o \frac{N_S^2}{B^3 d_s} \times f_s$
$= 3{\cdot}98 \times 10^{-7} \frac{LT_p^2 W_S^2}{D_e \gamma C'^2}$ $f_s = f(Re) = f\left(\frac{\delta_1 N_S}{d_s B}\right)$
$\delta_1 = \frac{144 D_e T_p W_S}{2{\cdot}42 \mu C'}$
AFFLE PITCH IN INCHES.
30
20 18 16 14 12 10
9 8 7 6 5 4 3
$z_o = 3{\cdot}98 \times 10^{-7} \frac{LT_p^2 W_S^2}{D_e \gamma C'^2}$
$z_o = 10^9$
10^8
10^7
10^6
$z_o = 10^5$
100
10
1·0
0·1
0·01
ΔP_S PRESSURE DROP SHELL SIDE IN P.S.I.
10^{-7} 10^{-6} 10^{-5} 10^{-4}
$\frac{f_s}{B^3}$
10^{-8} 10^{-7} 10^{-6}
$\frac{f_s N_S^2}{B^3 d_s}$
10^{-8}
10^{-7}
10^{-6}
$\frac{f_s}{B^3 d_s}$
$N_S = 1$ 2 4
48 45 42 39 37 35 33 31 29 27 25 23
8 10 12 13 15 17 19 21 23
HELL DIAMETER IN INCHES.
N_S, NUMBER OF SHELL PASSES.

TUBE-SIDE HEAT TRANSFER

e equation (7).

$$h_T = J_H \frac{k}{D}\left(\frac{2.42\mu c}{k}\right)^{1/3}$$

ıe equivalent area for heat flow on the outside of is diminished by the ratio of tube OD to tube ID.

ce, tube-side resistance to heat flow,

$$S_T = \frac{1000 \dfrac{\text{OD tube}}{\text{ID tube}}}{h_T} = \frac{A}{h_T}$$

$$= \left[\frac{A}{R_T k\left(\frac{2.42\mu c}{k}\right)^{1/3}}\right] \frac{1}{f(\beta_1 \times C_T)} = \frac{f(\beta_1 \times C_T)}{\rho} \qquad (12)$$

where ρ and β_1 are constants for a particular fluid and C_T could be plotted against standardised heat exchangers.

EXAMPLE

To illustrate the use of the graphical design method the following example is included:

The following process information is known about the fluids and the heat exchanger.

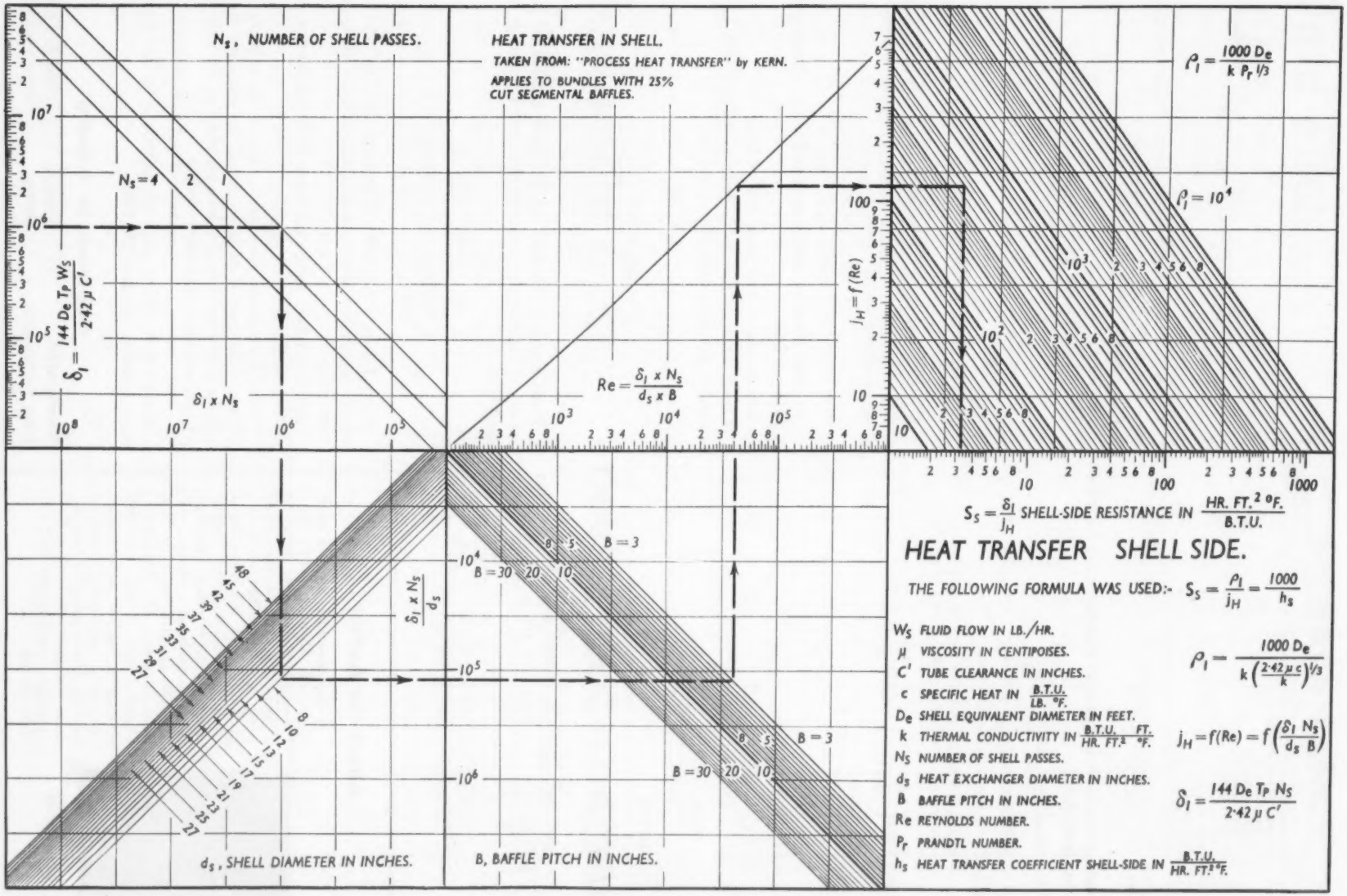
N_s, NUMBER OF SHELL PASSES.
$N_s = 4$ 2 1
$\delta_1 = \frac{144\ De\ T_P\ W_S}{2{\cdot}42\ \mu\ C'}$
$\delta_1 \times N_s$
HEAT TRANSFER IN SHELL.
TAKEN FROM: "PROCESS HEAT TRANSFER" by KERN.
APPLIES TO BUNDLES WITH 25% CUT SEGMENTAL BAFFLES.
$Re = \frac{\delta_1 \times N_s}{d_s \times B}$
$j_H = f(Re)$
$\rho_1 = \frac{1000\ De}{k\ P_r^{1/3}}$
$\rho_1 = 10^4$
10^3
10^2
$S_s = \frac{\delta_1}{j_H}$ SHELL-SIDE RESISTANCE IN $\frac{HR.\ FT.^2\ ^oF.}{B.T.U.}$
HEAT TRANSFER SHELL SIDE.
THE FOLLOWING FORMULA WAS USED:- $S_s = \frac{\rho_1}{j_H} = \frac{1000}{h_s}$
W_S FLUID FLOW IN LB./HR.
μ VISCOSITY IN CENTIPOISES.
C' TUBE CLEARANCE IN INCHES.
c SPECIFIC HEAT IN $\frac{B.T.U.}{LB.\ ^oF.}$
D_e SHELL EQUIVALENT DIAMETER IN FEET.
k THERMAL CONDUCTIVITY IN $\frac{B.T.U.}{HR.\ FT.^2\ ^oF.} \frac{FT.}{}$
N_S NUMBER OF SHELL PASSES.
d_s HEAT EXCHANGER DIAMETER IN INCHES.
B BAFFLE PITCH IN INCHES.
Re REYNOLDS NUMBER.
P_r PRANDTL NUMBER.
h_s HEAT TRANSFER COEFFICIENT SHELL-SIDE IN $\frac{B.T.U.}{HR.\ FT.^2\ ^oF.}$
$\rho_1 = \frac{1000\ De}{k\left(\frac{2{\cdot}42\ \mu\ c}{k}\right)^{1/3}}$
$j_H = f(Re) = f\left(\frac{\delta_1\ N_S}{d_s\ B}\right)$
$\delta_1 = \frac{144\ De\ T_P\ N_S}{2{\cdot}42\ \mu\ C'}$
$\frac{\delta_1 \times N_s}{d_s}$
B = 30 20 10 5 3
d_s, SHELL DIAMETER IN INCHES.
B, BAFFLE PITCH IN INCHES.

Figure 5

	Shell Side	Tube Side
Q — Heat duty Btuh	3.9×10^5	.....
ΔP — permissible pressure drop, psi	1	1
T_1, t_1 — Inlet temperature °F	250	100
T_2, t_2 — Outlet temperature °F	200	120
W — fluid flow (W_s and W_t) lb/hr	8×10^3	2×10^4
μ — viscosity, centipoise	0.196	0.582
c — specific heat	0.359	0.65
k — thermal conductivity Btu/hr/ft²/ft/°F	0.226	0.797
γ — specific gravity	0.987	0.8
f — Fouling Factor (f_s and f_t)	0.002	0.001
M — Tube metal heat resistance	0.00015	.....

1" tubes 16 SWG on 1¼"□ pitch, 8-feet long.

Finding a suitable size of heat exchanger for 3.9×10^5 Btu/hr. heat duty.

Using the above data we get:

C^1 = tube clearance for 1-in. tubes on 1¼-in. pitch = .25 in.

k_0 = C_T correction factor = 1.

R_T = inverse of tube ID, feet. For 1-in. tubes 16 SWG, ID = .87 in. = .0725 ft. $R_T = 13.8\ ft^{-1}$.

$$A = 1000\left(\frac{\text{tube OD}}{\text{tube ID}}\right) = 1000\,\frac{1.0}{.87} = 1150$$

$$\Delta T = \frac{120 - 100}{\log_e \frac{120}{100}} = 110°\ F.$$

T_p = tube pitch = 1.25 in.

$$D_e = 4\,\frac{[T_p^2 - \pi d_o^2/4]}{4\pi d_o/4} \times \frac{1}{12}$$

$$= 4\,\frac{[1.25^2 - \pi 1^2/4]}{4\pi 1/4} \times \frac{1}{12}$$

$$= .0825\ ft.$$

$$\delta_1 = \frac{144\,D_e T_p W_s}{2.42\mu C^1} = \frac{144 \times .0825 \times 1.25 \times 8 \times 10^3}{2.42 \times .196 \times .25} = 10^6$$

$$\rho_1 = \frac{1000\,D_e}{k\left(\frac{2.42\mu c}{k}\right)^{1/3}} = \frac{1000 \times .0825}{.226\left(\frac{2.42 \times .196 \times .359}{.226}\right)^{1/3}} = 400$$

$$\beta_1 = \frac{W_t k_o}{2.42\mu R_T} = \frac{2 \times 10^4 \times 1}{2.42 \times .582 \times 13.8} = 10^3$$

About the Author

Starczewski

J. Starczewski is an area engineer with Constructors John Brown, Ltd., London. Prior to joining this firm he was doing work in heat exchanger design, pressure vessel design, welding equipment development, special purpose machine design and other process equipment design. He also did research work in fluid flow problems. Mr. Starczewski attended the Polish Technical College in England and completed a B.Sc. mechanical course at London University. He has also done post graduate work in fluid dynamics, mathematics and nuclear energy.

$$\rho = \frac{A}{kR_T\left(\frac{2.42\mu c}{k}\right)^{1/3}} = \frac{1150}{.797 \times 13.8\left(\frac{2.42 \times .582 \times .65}{.797}\right)^{1/3}} = 100$$

Try 8-inch heat exchanger, 3-inch baffle pitch, 2 tube passes (N_T), and 1 shell pass (N_s).

From Figure 5: $S_s = 3.3$

Assume $C_T = 10$

Then from Figure 2: $S_T = 2.4$

S = total resistance to heat flow

$= (S_T + S_s) + 1000\,(f_s + f_t + M)$

$= (2.4 + 3.3) + (.002 + .001 + .00015)$

$= 8.85$

$$\text{Heating Area Required} = \frac{QS}{1000\,(E\Delta T)}$$

E is obtained from the appropriate graph in TEMA. E for 1 shell pass and 2 tube passes and temperatures as given above = .98.

$$\text{Area required} = \frac{3.9 \times 10^5 \times 8.75}{1000\,(.98 \times 110)} = 31.7\ ft^2$$

Assumed effective tube length is 7.65 ft., actual tube length is 8 feet.

Actual area = $31.7 \times 8/7.65 = 33\ ft^2$

Check whether the above heat exchanger will have a smaller pressure drop than specified.

$$\delta_1 = 10^6$$

$$Z_o = 3.98 \times 10^{-7}\,\frac{LT_p^2 W_s^2}{D e \gamma (C^1)^2}$$

$$= 3.98 \times 10^{-7}\,\frac{8 \times 1.25^2 \times (8 \times 10^3)^2}{.0825 \times .987 \times (.25)^2} = 10^5$$

From Figure 4 the shell side pressure drop is 0.75 psi. which is smaller than permissible pressure drop on shell side.

$$\beta_1 = 10^3$$

$$Z = \frac{k_o^2 W_T^2 N_T}{\gamma 10^{12}} = \frac{1 \times (2 \times 10^4)^2 \times 2}{.8 \times 10^{12}} = 10^{-3}$$

From Figure 3 the tube side pressure drop is 0.124 psi which is smaller than permissible pressure drop on tube side.

Hence, an 8-in. heat exchanger is acceptable for the duty specified.

Note: Such parameters as D_e, R_T, A, A_1 relating to various tube and shell sizes should be compiled in a tabular form, thereby avoiding calculations for individual cases of heat exchanger design.

Based on an article originally published in *The Engineer*, London, January 27, 1961.

Key Words for Indexing

Nomographs	Flow	Shell & Tube
Heat Exchangers	Design	Pressure Drop
Heat Transfer	Fluids	Size

Equipment Cost Data File

SPHERICAL PRESSURE STORAGE TANKS

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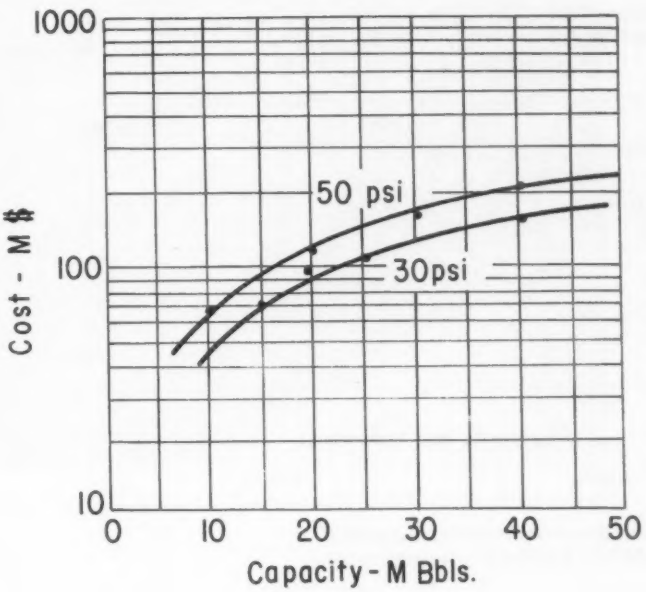
John Mylo The Chemstrand Corp., Decatur, Ala.

SPHERICAL STORAGE tanks utilize material to the best advantage, resulting in a reasonably low cost per barrel of liquid for storage pressures of 30 pounds per square inch or greater since it has less surface area for a given capacity than any other container shape.

The cost of spherical storage tanks delivered and erected, on customer's foundation can be estimated from this chart. These tanks can be supported by cylindrical columns attached to the shell and resting on individual concrete piers. The upper section of each column is usually welded to the shell plate and stress relieved in the shop.

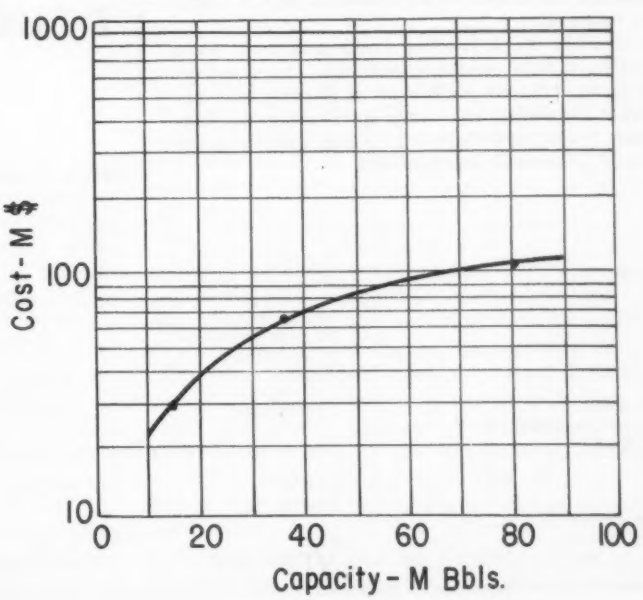
These spheres are furnished with a standard set of accessories including a spiral stairway, handrail at top, manholes, relief valves, gaging and float devices and flanged connections for the usual appurtenances.



Equipment Cost Data File

DOUBLE DECK FLOATING ROOF TANKS

THE DOUBLE DECK floating roof is the most efficient type of floating roof. The air space between the decks provides insulation over the entire surface of the liquid. Basic costs for this type storage tank can be estimated from this chart. Actual cost of specific tanks with design data are on the reverse side.



Key Words for Indexing

Costs Tanks

See "New Information Retrieval Standards," PETROLEUM REFINER, May 1961, p263.

SPHERICAL PRESSURE STORAGE TANKS

The spherical storage tank is usually economical for storage pressures above 30 pounds per square inch. It is built of steel plates that have been formed, cut to the required size and the edges prepared for welding in the shop. However, because of their size, spherical storage tanks are field erected. Welded construction is used throughout and principal connections, such as nozzles and supports are usually welded to the shelf plates during shop fabrication. The costs for this type storage vessel were obtained from firm vendor quotations.

Date:	3–20–60	3–20–60	3–20–60
M/S Index:	237	237	237
Type:	Sphere	Sphere	Sphere
Size:	48 Foot ∅	61 Foot ∅	69 Foot ∅
Capacity, Barrels:	10,000	20,000	30,000
Working Pressure, psig:	50 psi	50 psi	50 psi
Material of Construction:	C/S	C/S	C/S
Price:	$68,000	$112,000	$163,000
Weight:	.....	.....	.....
F.O.B.	Pensacola	Pensacola	Pensacola
Cost per Barrel:	$6.80	$5.85	$5.43
Cost per Pound:	.....	.....	.....
Code:	ASME	ASME	ASME

Keywords for Indexing:

Costs, Tanks

See "New Information Retrieval Standards," PETROLEUM REFINER, May 1961, p263.

DOUBLE DECK FLOATING ROOF TANKS

The double deck floating roof tank has a double deck over the entire liquid surface with a vertical rim at the perifery. The top deck is pitched downward toward the center and the bottom deck is coned slightly upward.

The double deck floating roof tank costs were obtained from firm vendor quotations. The standard fittings furnished with each type of floating roof are as follows: manholes, rim vent, spiral stairway, ladder, roof drain, roof supports, gauge hatch, guide device and automatic bleeder vent.

Date:	3–20–60	3–20–60	3–20–60
M/S Index:	237	237	237
Mfr.:	.....	.....	.....
Capacity:	14,000 Barrels	36,000 Barrels	80,000 Barrels
Size:	50 Foot Diameter 40 Foot High	80 Foot Diameter 40 Foot High	120 Foot Diameter 40 Foot High
Type:	Vertical Cylindrical	Vertical Cylindrical	Vertical Cylindrical
Tank Pressure:	Atmosphere	Atmosphere	Atmosphere
Material of Construction:	.....	.....	.....
Type of Roof:	Double Deck Floating Roof	Double Deck Floating Roof	Double Deck Floating Roof
Weight:	.....	.....	.....
Price:	$29,500	$55,000	$105,000
F.O.B.:	Florida	Florida	Florida
Price per Pound:	.....	.....	.....
Price per Barrel:	$2.11	$1.53	$1.31
Code:	API Standard	API Standard	API Standard

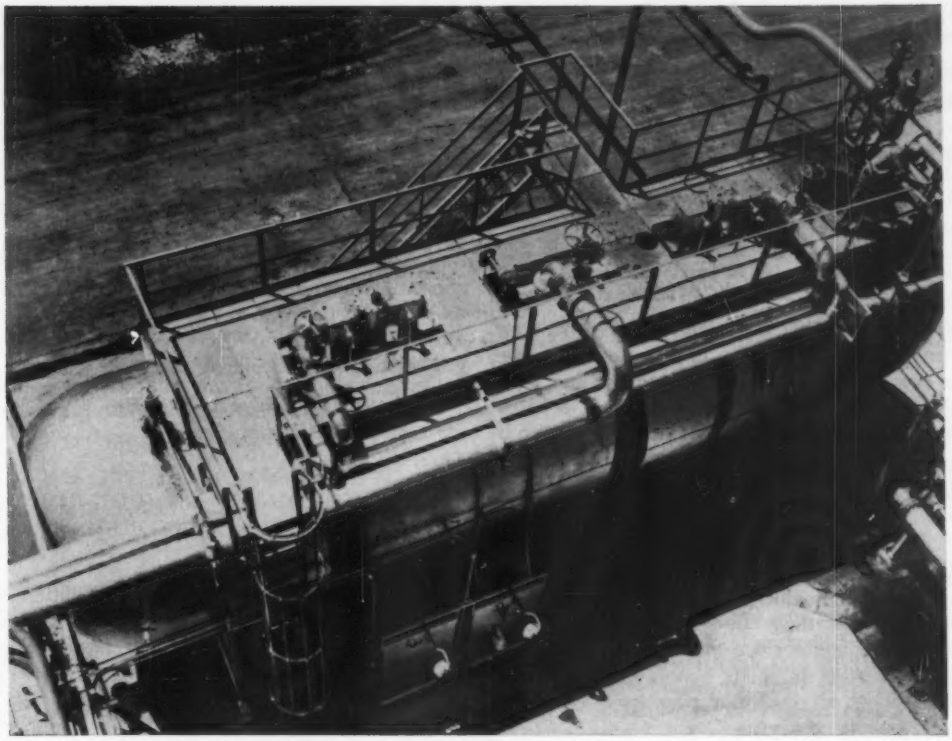


FIGURE 1—Clean desalted crude flows from the top of the desalting vessel to the refinery flow circuit.

Check This Payout on Crude Desalting

Compare your crude treating situation with the example given here. See how much it is worth to have crude desalting in your plant

Carl E. Bochow and William M. Fisher
Howe-Baker Engineers, Inc., Tyler, Texas

Several credits are gained when electrical desalting is installed on crude units. The example here shows an annual savings of $140,300 when there is no need for incremental crude capacity. When more capacity is required, the total credit jumps to $419,200 per year. In either case, a non-recurring credit of $60,000 exists for releasing crude tank capacity.

These credits give adequate budget justification for new electrical desalting units. For example, in these two situations the payout for a desalter, after taxes, is 2.31 years when no incremental crude capacity is needed and 0.82 years when more capacity is required. These payouts are based on an installed cost of $170,000, seven percent depreciation and 52 percent taxes.

To date, an estimated 8,000,000 barrels per day of desalting capacity are in operation. It is standard procedure to specify crude desalting as an integral part of most new crude units being built. Even when operation on high salt content crudes is not contemplated, salt water removal and the removal of solids from the crude is today considered sufficient justification for installing desalters, thereby insuring optimum economical refinery operation.

For the refiner who has no desalters in operation and is investigating the need for new desalting capacity, the precise economic evaluation is difficult because no prior operating data on such factors as reduced maintenance or incremental service factor are available. The refiner with existing desalting capacity can use known credits from existing units to justify new installations. The refiner who desires incremental desalting capacity or increased efficiency of present desalters can calculate economic savings by assuming that maintenance costs and service factors are a function of salt removal from the crude.

Extensive data have been collected from long term users of desalting apparatus and analyzed to determine

those values which are generally applicable rather than specific to a local situation. These data represent, in some cases, as much as 10-year averages on the effect of desalting on maintenance and service factor. The following example illustrates how these average data can be applied to any refinery which wishes to evaluate either new or incremental desalting capacity.

BASIS FOR JUSTIFICATION

In order to illustrate the calculation procedure used when determining the economic justification of crude desalting, a crude with moderate salt content and typical inspections has been selected. This crude will be of 30° API gravity and have a salt content of 0.04 pounds per barrel. In actual practice, crudes can range in salt content from 0.001 to 2 lb/bbl crude. In the United States, where salt content is low, as compared to foreign crudes, a typical figure is 0.04 lb/bbl.

A BS&W content of 0.7 percent has been selected as typical for this example since it is assumed the crude would have normal settling time in tankage. Factors which affect BS&W content are viscosity, production methods, transportation methods, amount of naturally occurring emulsifiers, degree of mixing from pumping and residence time in storage.

The results of crude desalting not only affect crude unit operation but also the operation of other refinery process units. In an economic analysis, the disposition of crude unit product streams, as well as subsequent processing sequence, are needed to establish credits. For this problem, it is assumed crude is heated to a temperature of 250° F, desalted and then additional heat added to raise the crude to 550° F, at which point the crude is topped in a preflash tower. Straight run gasoline is reformed, gas oil is catalytically cracked, and residuum is thermally cracked or coked.

Expected desalter performance will vary depending on the type of crude being processed and the desalting equipment being used. Normally, the salt content of the crude is reduced by approximately 95 percent while the BS&W content is reduced to the 0.2 percent level or below. These figures will be used for evaluating the justification for the addition of new desalting capacity in a 60,000 bpsd refinery.

Service factor has been assumed to be 88 percent before desalting. It has been calculated that, on this particular crude, the service factor could be increased to 95 percent if desired. The 88 percent service factor has been used for calculating savings on a fixed crude basis and the 95 percent on an increased capacity basis.

Table 1 summarizes the expected desalter performance and major credits associated with crude desalting. Each credit will be discussed individually in the following desalter justification.

TABLE 1—Expected Performance of Electrical Desalter

Crude Contaminants	Before	After
Salt, lb/bbl	0.040	0.002
BS&W, vol %	0.7	0.2

Fuel Savings. A credit can be calculated for better utilization of refinery fuel gas by removing water from the crude and reducing fouling of heat transfer equipment, distillation towers and fired heaters.

Each pound of water in the crude requires 970 Btu per pound to raise it from a 250° F liquid (common desalting temperature) to a 550° F vapor. Any heat which is required for the processing of water is not available for oil processing and the fired heater is required to supply enough additional heat to maintain a constant transfer line temperature. By eliminating the majority of this water the fuel gas requirements are reduced, resulting in decreased utility costs. The fuel gas savings are calculated using:

Fuel gas value, ¢/million Btu.....28
Heater efficiency, % 67

Then

$$\text{Savings} = (60{,}000)(365)(0.88)(0.007\text{-}0.002)(42)(970)(8.33)(0.28 \times 10^{-6})/0.67$$
$$= \$13{,}600 \text{ per year}$$

Fouling of preheat exchangers, distillation equipment and fired heaters is increased by salt and suspended solids in the crude. The salt and suspended solids are usually contained either in or on the dispersed water droplets. The removal of these water droplets from the crude therefore greatly reduces the impurities which are responsible for the fouling problem.

A typical large crude unit uses as fuel approximately 90,000 Btu/bbl. of oil processed. Data gathered from refineries which have installed crude desalting show that the fuel gas requirements have been reduced on the average by approximately 0.13 percent for each reduction of 0.001 pound of salt per barrel.

$$\text{Savings} = (60{,}000)(365)(0.88)(90{,}000)(0.0013/0.001)(0.040\text{-}0.002)(0.28 \times 10^{-6})$$
$$= \$23{,}700 \text{ per year}$$

Reduced Maintenance. The salt in crude oil hydrolyzes to HCl and the attendant damage to furnace tubes, vessels, trays, tower lining and overhead equipment is considerable, even when corrosion prevention programs, such as ammonia injections, are followed. In addition to corrosion, serious salt fouling of exchangers increases turnaround labor costs because of additional manpower required to clean these items of equipment. Furnace tubes and headers fall into the same classification. Both corrosion and salt fouling are serious debits which can be partly or completely eliminated by desalters.

Four refineries evaluated the maintenance savings which could be credited to installation of electrical crude desalters. They maintained careful cost records before and after desalter installation on items such as tower linings, trays and other internals, exchanger tubes and baffles, overhead equipment including vapor lines and condensing equipment, furnace tubes, etc. The weighted average results of the studies from these companies established that removal of salt through electrical desalting reduces maintenance as follows:

Charge rate, bpcd 42,500
Salt removal, lb/bbl 0.0397
Maint. reduction, $/yr 73,000

From these data, it can be assumed maintenance costs will be reduced daily by 12 cents per pound of salt removed. This means an annual credit for the example desalter installation of:

$$\text{Savings} = (60{,}000)\,(365)\,(0.88)\,(0.040\text{-}0.002)\,(0.12)$$
$$= \$87{,}800 \text{ per year}$$

Cooling Water Savings. The additional heat required to vaporize any water in the crude must be removed in the crude tower overhead system with cooling water. About five gallons of cooling water are required for each pound of water in the crude, assuming a 25° F temperature rise in the cooling water. Pumping, make-up, chemical costs and depreciation are estimated to be 1.5 cents per 1,000 gallons of cooling water.

$$\text{Savings} = (60{,}000)\,(365)\,(0.88)\,(0.007\text{-}0.002)\,(42)\,(8.33)\,(5)\,(0.015 \times 10^{-3})$$
$$= \$2{,}500 \text{ per year}$$

Ammonia Savings. Assumed to be a straight line function of salt removal, ammonia savings can be calculated if present ammonia usage and cost are available. Ammonia requirements vary widely with the type of crude being processed and it is best to consider the savings as a percentage of present ammonia cost.

In the example, expected ammonia savings would be 95 percent of existing cost since the salt content is being reduced from 0.040 to 0.002 pounds per barrel or by 95 percent. It has been assumed ammonia costs were $5,000 per year for the crude unit without desalters. Ammonia savings of $4,700 per year could be credited to installing an electrical desalter on a fixed crude basis.

Increased Tank Capacity. Refineries are usually limited in their crude storage facilities and tie up about 2 to 8 percent of the existing tankage capacity as a working zone for BS&W. These tanks have to be periodically cleaned to remove the nondrainable sludge which remains in the bottom of the tank. Desalting of crude results in using the complete tank for storage purposes since the crude suction line can be lowered to the bottom of the tank. Lowering the suction line to the bottom of the tank permits full utilization of tankage capacity and also eliminates tank cleaning and its associated problem of sludge disposal. On a non-recurring basis, the tankage thus gained is worth approximately $2 per barrel. A recurring savings of 2 cents per year per barrel of crude storage capacity will be realized in eliminating cleaning.

It has been assumed that four 100,000 barrel crude tanks, 40 feet high, are used for crude inventory for the 60,000 barrels per day crude unit. Installation of desalters would permit lowering the crude suction lines from three feet to tank bottom and eliminate tank cleaning. A non-recurring credit of $60,000 is associated with the released tank volume. A recurring tank savings of $8,000 per year will be obtained by eliminating cleaning.

Other Credits. Other monetary credits exist for the installation of electrical desalters. The value of those credits, however, are not covered here because their magnitude will vary so much from refinery to refinery. The operation of cracking facilities can be improved through the removal of salt and metallic contaminants, such as nickel, vanadium, sodium and iron. All of these contaminants are recognized to be serious poisons for cracking catalysts. While electrical desalting does not completely remove all the catalytic cracking contaminants it does help to reduce their concentration through the removal of colloidal-dimensioned suspended solids. The removal of poisons reduces catalyst makeup and increases catalyst activity resulting in higher yields of gasoline and lower yields of cycle gas oils.

Salts also catalyze cracking in thermal units and promote coking of furnace tubes. The removal of salt from feed streams to thermal crackers and visbreakers greatly reduces maintenance costs and improves gasoline-coke relationships.

Crude desalters can eliminate pipestill upsets caused by slugs of water being charged to the crude unit. Damage to trays and tower internals can result from water being charged to a crude unit, along with operational upsets causing crude tower products to go off specifications. An example of the latter would be the naphtha side stream going to reformer feed which is thrown off color when the fractionation tower becomes upset. This off-specification naphtha would have to be slopped and re-run with its ultimate disposition being regular grade gasoline. Eliminating such upsets, along with the asso-

How Electrical Desalting Works . . .

SALTS IN CRUDE are most generally contained in residual water which is suspended in the oil phase. The chemical composition of these salts varies widely, with the major portion being sodium chloride with lesser amounts of calcium and magnesium chlorides. All crude oils also contain, as mechanical suspensions, such impurities as silt, iron oxides, silica or quartz sand and crystalline salt.

Depending on the characteristics of the crude being desalted, optimum desalting temperatures will be in the range of 150 to 300° F. The desalter is located in the pipestill preheat train such that the desired temperature can be obtained by heat exchange between the pipestill products or recirculated reflux and the crude charge.

All desalters require the addition of substantial quantities of wash water, usually 4 to 8 percent by volume, to the crude charge stream. The wash water is added to the raw crude to dissolve and/or wet the impurities. The water is mixed under controlled conditions with the crude to form a stable water-in-oil emulsion. The properties of the emulsion are controlled by adjusting the pressure drop across a specially designed mixing valve. The emulsion thus formed is resolved by introducing it into a high voltage electrostatic field inside the desalting vessel.

The action of the field is to agglomerate the dispersed water phase and force its accumulation in the bottom of the vessel. The electrodes, between which the field is maintained, are set at such spacing that the voltage intensity is in the order of 2,000 to 5,000 volts per inch of separation. The applied voltage ranges from 13,000 to 35,000 volts. The water, which contains the various impurities removed from the crude, is continuously discharged to the effluent system. Clean desalted crude flows from the top of the desalting vessel to the refinery flow circuit.

ciated down-grading of products, is a credit which could be determined and applied to justifying the installation of desalters.

Increased Capacity. Four companies supplied the weighted average improvement in service factor due to installation of desalters. These companies are the same four referred to in the discussion on reduced maintenance. Their improved service factor was determined to be equal to 0.18 per cent for each reduction of 0.001 pound of salt per barrel. Unless the refiner has need for additional crude running capacity or can shut down high cost small crude units, little credit exists for improved service factor; however, if either of these conditions do exist, incremental capacity could be valued at 10 cents to 20 cents per barrel.

For the example, it is assumed that incremental capacity is valued at 10 cents per barrel. The resultant savings would be:

Savings = (60,000) (365) (0.95-0.88) (0.10)
= $153,000 per year

Should the need exist for additional capacity above the improved service factor, it could be obtained if the crude unit is limited by heater capacity. The credit for additional crude capacity would be taken rather than the fuel and cooling water savings. Heater firing would remain constant and any reduction in Btu input because of reduced water in the crude or better exchanger transfer would be cancelled by charging more crude.

Crude capacity could be increased by 4,620 bpsd, if the example unit is heater limited. This is based on using the total fuel saving of 416×10^6 Btu/stream day and that processing each barrel of crude requires 90,000 Btu of fuel. This further assumes all other items of process equipment in the distillation unit can handle the additional throughput. This additional capacity is worth $159,000 per year at 10 cents per barrel.

The removal of water from the crude reduces the vapor loading on the fractionation tower and should permit using a major portion if not all of the incremental capacity made available by reduced heater loading. Assume the molecular weight of the vapor at the critical point of the tower is 160. Therefore, 160/18 or 8.9 pounds of oil vapor can replace one pound of water vapor. For the example, the tower loading will be essentially unchanged when charging an additional 3000 bpsd of crude.

Summary. The credits for installing an electrical desalter on the example crude unit are summarized in Table 2. Two different yearly savings have been tabulated. In Case I, it is assumed that no need exists for incremental crude capacity. Under this condition, total savings amount to $140,300 per year. However, the total credit increases to $419,200 per year, as shown in Case II, if incremental crude capacity is required. In both cases, a non-recurring credit of $60,000 exists for released crude tank capacity.

Payout for the desalter, after taxes, is 2.31 years in Case I and 0.82 years in Case II. These payouts are based on an installed cost of $170,000, seven percent depreciation and 52 percent taxes.

TABLE 2 SUMMARY OF CREDITS
$1/Year (Unless Noted)

CASE	I	II
Basis	Fixed Crude	Increased Crude
Service Factor	88%	95%
a. Fuel Savings		
Water Removal	13,600	0
Reduced Fouling	23,700	0
b. Reduced Maintenance	87,800	94,500
c. Cooling Water Savings	2,500	0
d. Ammonia Savings	4,700	4,700
e. Tankage Cleaning Savings	8,000	8,000
f. Increased Service Factor	0	153,000
g. Increased Capacity—heat input limited	0	159,000
Total Recurring Credits	140,300	419,200
Investment (including installation)	170,000	170,000
Depreciation at 7%	11,900	11,900
Taxes at 52%	66,800	211,800
Return After Taxes (1)	69,400	207,400
Payout Time in Years (after taxes)	2.31	0.82

(1) Plus non-recurring savings of $60,000 for released crude tank capacity.

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About the Authors

Carl E. Bochow is manager of the East Coast Division of Howe-Baker Engineers, Inc. Mr. Bochow received his professional degree in petroleum refining engineering from Colorado School of Mines in 1952, after which he joined Humble Oil & Refining Company's Technical Service Division as a junior chemical engineer. Before assuming his present position of Eastern Division Representative, he held the title of chief process engineer for Suntide Refining Company in Corpus Christi, Texas, for six years where he was responsible for all process design and control, economic analysis and crude evaluation. He is a registered professional engineer in Texas.

Bochow

William M. Fisher is a senior process engineer with Howe-Baker and his experience with them has included technical sales representation, pilot unit operation, design and startup of both electrical desalters and distillate treaters. After graduating from Purdue University in 1951 with a B.S. degree in chemical engineering, Mr. Fisher worked for the Fluor Corporation in Los Angeles. Assignments at Fluor included process design on most types of major refinery processing units along with a one year company-wide training program. He joined Lago Oil and Transport Company, Aruba, Netherlands Antilles in 1954, where he became supervisor in Technical Service Department. He has been with Howe-Baker since 1958 and is a registered professional engineer in Texas.

Fisher

Thermo Data for Petrochemicals

Part 30: Gaseous Normal-1-Alkanethiols. The important thermo properties are presented for all gaseous n-1-alkanethiols from methanethiol through n-decanethiol

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MEASUREMENTS and calculations made on the thermodynamics of organic sulfur compounds during the last decade have yielded sufficient data to make it worthwhile summarizing these data and extending them to the higher homologs. With the help of the data thus found, contributions to the free enthalpy of formation (Gibbs' free energy of formation) for sulfur groups can be calculated. In this article data will be presented on normal alkanethiols and on the contribution of a primary-SH group to the free enthalpy of formation. In forthcoming communications data on other organic sulfur compounds will be given.

METHOD OF CALCULATION

Literature Data. Heats of formation of methanethiol, ethanethiol, propanethiol, butanethiol and pentanethiol are given in Table 1. To bring the literature values in line with a recent redetermination[1] of the heat effect of the reaction

$$S\,(rh) + 56\,H_2O\,(l) + 2\,O_2\,(g) \rightarrow H_2SO_4 \cdot 55\,H_2O\,(l)$$

the heats of formation listed in Table 1 have been corrected accordingly. Calculating the heat effect of the reaction*

$$C_nH_{2n+1}SH\,(g) + H_2\,(g) \rightarrow C_nH_{2n+2}\,(g) + H_2S\,(g)$$

at 298.15 °K, we find for methanethiol —17.24 $\frac{kcal}{mole}$; ethanethiol —13.88 $\frac{kcal}{mole}$; propanethiol —13.45 $\frac{kcal}{mole}$; butanethiol —13.85 $\frac{kcal}{mole}$ and pentanethiol —13.38 $\frac{kcal}{mole}$. For the higher homologs we assume this heat effect to be —13.56 $\frac{kcal}{mole}$ (the average value for propane-, butane- and pentanethiol). Using this average value we find for the higher homologs ($n > 5$) at 298.15 °K

$$\underset{C_nH_{2n+1}SH}{\Delta H_f^\circ} = \underbrace{\Delta H_f^\circ_{\,C_nH_{2n+2}}}_{\text{Reference state } S(rh)} + 8.74 = \underbrace{\Delta H_f^\circ_{\,C_nH_{2n+2}}}_{\text{Reference state } S_2(g)} - 6.68$$

Heats of formation calculated in this way are also given in Table 1.

* The heats of formation of the alkanes were taken from Rossini et al.,[12] the heat of formation of hydrogen sulfide from Evans and Wagman.[14]

TABLE 1

Thiol		Reference state S rh $\Delta H_f°$ 298.16 °K, kcal/mole	Reference state S_2 g $\Delta H_f°$ 298.16 °K, kcal/mole	Literature Reference
Methanethiol	(g)	— 5.47	—20.89	2
Ethanethiol	(l)	—17.76 ± 0.16		3
	(g)	—11.18 ± 0.18	—26.60 ± 0.20	3
n-Propanethiol	(l)	—23.84 ± 0.16		4
	(g)	—16.19 ± 0.20	—31.61 ± 0.24	4
n-Butanethiol	(l)	—30.15 ± 0.28		5
	(g)	—21.02 ± 0.31	—36.44 ± 0.35	5
n-Pentanethiol	(l)	—36.27 ± 0.41		6
	(g)	—26.44 ± 0.45	—41.86 ± 0.49	6
n-Hexanethiol	(g)	—31.22 ± 0.50	—46.64 ± 0.54	Inaccuracy estimated
n-Heptanethiol	(g)	—36.15 ± 0.55	—51.57 ± 0.59	
n-Octanethiol	(g)	—41.08 ± 0.60	—56.50 ± 0.64	
n-Nonanethiol	(g)	—46.00 ± 0.65	—61.42 ± 0.69	
n-Decanethiol	(g)	—50.93 ± 0.70	—66.35 ± 0.74	

Experimental entropies given in the literature are presented in Table 2.

TABLE 2

Thiol		Temperature °K	S cal/mole °K	Literature Reference
Methanethiol	(g)	279.12	60.16 ± 0.10	7
Ethanethiol	(l)	298.15	49.48 ± 0.10	8
n-Propanethiol	(l)	298.15	57.96 ± 0.10	4
n-Butanethiol	(l)	298.15	65.96 ± 0.13	5
n-Pentanethiol	(l)	298.15	74.18 ± 0.15	9

Thermodynamic Properties as a Function of Temperature

Methanethiol. Thermodynamic properties of methanethiol were calculated, using molecular and spectroscopic data. Structural information was taken from papers of Kojima and Nishikawa.[10] Using their data we calculated for the product of the principal moments of inertia $I_1 I_2 I_3 = 35.946 \times 10^{-117}$ g³cm⁶; for the reduced moment of internal rotation $I_{red} = 1.859 \times 10^{-40}$ gcm² was found. The barrier hindering internal rotation proved to be $V_{3H} = 1320 \pm 100 \frac{cal}{mole}$ which is in good agreement with the value mentioned by Kojima and Nishikawa. As characteristic vibration we chose;[11,12] 703, 805, 955, 1070, 1428, 1470, 2572 and 2950 (3) cm^{-1}. Thermodynamic properties calculated in this way are listed in Tables 3, 4, 5 and 6.

Ethanethiol. Thermodynamic properties of ethanethiol were taken from the U.S. Bureau of Mines publications[3,8] and are given in Tables 3, 4, 5 and 6.

n-Propanethiol. Thermodynamic properties of n-propanethiol were taken from the U.S. Bureau of Mines publication[4] and are given in Tables 3, 4, 5 and 6.

n-Butanethiol. Thermodynamic properties of n-butanethiol were calculated by the U.S. Bureau of Mines group[5] using a "refined method of increments." They assumed

TABLE 3*

Compound	TEMPERATURE °K: 0	273.15	298.15	300	400	500	600	700	800	900	1000
	Heat capacity $C_p°$ cal/mole °K										
CH_3SH	0	11.57	12.05	12.09	14.08	15.96	17.62	19.09	20.39	21.55	22.56
C_2H_5SH	0	16.46	17.37	17.44	21.08	24.36	27.21	29.68	31.83	33.71	35.38
n-C_3H_7SH	0	21.39	22.65	22.75	27.86	32.56	36.72	40.37	43.60	46.47	49.01
n-C_4H_9SH	0	26.65	28.24	28.37	34.98	41.03	46.33	50.95	55.00	58.57	61.73
n-$C_5H_{11}SH$	0	31.77	33.71	33.87	41.92	49.28	55.68	61.32	66.06	70.32	74.07
n-$C_6H_{13}SH$	0	36.89	39.18	39.36	48.87	57.52	65.02	71.60	77.13	82.07	86.40
n-$C_7H_{15}SH$	0	42.01	44.65	44.85	55.81	65.77	74.36	81.88	88.20	93.82	98.73
n-$C_8H_{17}SH$	0	47.13	50.11	50.35	62.75	74.01	83.70	92.15	99.26	105.56	111.07
n-$C_9H_{19}SH$	0	52.25	55.58	55.84	69.69	82.26	93.05	102.43	110.33	117.31	123.40
n-$C_{10}H_{21}SH$	0	57.37	61.04	61.34	76.63	90.50	102.39	112.70	121.39	129.05	135.73

* In order to retain internal consistency the values in this and the following tables are given to more decimal places than is warranted by the accuracy of the calculations.

TABLE 4

Compound	TEMPERATURE °K: 0	273.15	298.15	300	400	500	600	700	800	900	1000
	Enthalpy function $\frac{H°-H°_0}{T}$ cal/mole °K										
CH_3SH	0	9.53	9.72	9.73	10.57	11.47	12.35	13.21	14.03	14.80	15.57
C_2H_5SH		11.69	12.13	12.16	13.94	15.70	17.38	18.96	20.44	21.81	23.08
n-C_3H_7SH	0	14.95	15.54	15.59	18.03	20.47	22.83	25.08	27.19	29.81	31.04
n-C_4H_9SH	0	18.10	18.92	18.98	22.16	25.34	28.39	31.28	34.00	36.54	38.91
n-$C_5H_{11}SH$	0	21.25	22.25	22.33	26.23	30.12	33.83	37.35	40.64	43.72	46.57
n-$C_6H_{13}SH$	0	24.40	25.59	25.67	30.29	34.89	39.27	43.41	47.29	50.90	54.24
n-$C_7H_{15}SH$	0	27.55	28.92	29.01	34.35	39.66	44.71	49.47	53.93	58.08	61.90
n-$C_8H_{17}SH$	0	30.70	32.25	32.36	38.42	44.44	50.15	55.54	60.58	65.25	69.57
n-$C_9H_{19}SH$	0	33.85	35.58	35.70	42.48	49.21	55.59	61.60	67.22	72.43	77.23
n-$C_{10}H_{21}SH$	0	37.00	38.91	39.05	46.54	53.99	61.03	67.66	73.86	79.60	84.89

TABLE 5

Compound	TEMPERATURE °K										
	0	273.15	298.15	300	400	500	600	700	800	900	1000
	Free enthalpy function $\frac{G°-H°_o}{T}$ cal/mole °K										
CH_3SH	0	— 50.37	— 51.22	— 51.28	— 54.19	— 56.66	— 58.82	— 60.77	— 62.50	— 64.30	— 65.89
C_2H_5SH	0	— 57.60	— 58.64	— 58.72	— 62.46	— 65.76	— 68.72	— 71.58	— 74.21	— 76.69	— 79.07
n-C_3H_7SH	0	— 63.52	— 64.86	— 64.86	— 69.76	— 74.05	— 78.00	— 81.69	— 85.18	— 88.51	— 91.67
n-C_4H_9SH	0	— 69.14	— 70.70	— 70.81	— 76.61	— 81.99	— 86.89	— 91.49	— 95.85	—100.02	—103.97
n-$C_5H_{11}SH$	0	— 74.84	— 76.90	— 76.94	— 83.89	— 90.15	— 95.99	—101.47	—106.69	—111.66	—116.41
n-$C_6H_{13}SH$	0	— 80.54	— 82.87	— 83.04	— 91.05	— 98.30	—105.06	—111.43	—117.49	—123.27	—128.80
n-$C_7H_{15}SH$	0	— 86.24	— 88.85	— 89.04	— 98.11	—106.35	—114.03	—121.29	—128.20	—134.78	—141.10
n-$C_8H_{17}SH$	0	— 91.94	— 94.83	— 95.04	—105.17	—114.38	—123.00	—131.14	—138.90	—146.30	—153.40
n-$C_9H_{19}SH$	0	— 97.64	—100.81	—101.04	—112.23	—122.43	—131.97	—140.99	—149.60	—157.82	—165.70
n-$C_{10}H_{21}SH$	0	—103.34	—106.79	—107.03	—119.29	—130.47	—140.94	—150.85	—160.31	—169.34	—178.00

TABLE 6

Compound	TEMPERATURE °K										
	0	273.15	298.15	300	400	500	600	700	800	900	1000
	Entropy S° cal/mole °K										
CH_3SH	0	59.90	60.94	61.01	64.76	68.13	71.17	73.98	76.63	79.10	81.46
C_2H_5SH	0	69.29	70.77	70.88	76.40	81.46	86.16	90.54	94.65	98.50	102.15
n-C_3H_7SH	0	78.47	80.40	80.54	87.79	94.52	100.83	106.77	112.37	117.69	122.71
n-C_4H_9SH	0	87.24	89.62	89.79	98.87	107.33	115.28	122.77	129.85	136.56	142.88
n-$C_5H_{11}SH$	0	96.09	99.05	99.27	110.12	120.27	129.82	138.82	147.33	155.38	162.98
n-$C_6H_{13}SH$	0	104.94	108.46	108.71	121.34	133.19	144.33	154.84	164.78	174.17	183.04
n-$C_7H_{15}SH$	0	113.79	117.77	118.05	132.46	146.01	158.74	170.76	182.13	192.86	203.00
n-$C_8H_{17}SH$	0	122.64	127.08	127.40	143.59	158.82	173.15	186.68	199.48	211.55	222.97
n-$C_9H_{19}SH$	0	131.49	136.39	136.74	154.71	171.64	187.56	202.59	216.82	230.25	242.93
n-$C_{10}H_{21}SH$	0	140.34	145.70	146.08	165.83	184.46	201.97	218.51	234.17	248.94	262.89

$$C_p°(C_4H_9SH) = 2\,C_p°(C_3H_7SH) - C_p°(C_2H_5SH) + a$$

$$S°(C_4H_9SH) = 2\,S°(C_3H_7SH) - S°(C_2H_5SH) + a\ln T + b$$

$$(H° - H_o°)\,(C_4H_9SH) = 2(H° - H_o°)\,(C_3H_7SH) - (H° - H_o°)\,(C_2H_5SH) + aT$$

The constants a and b were selected so as to agree with experimental heat capacities and entropies in a temperature interval (300 . . . 500 °K). In this paper the term "refined method of increments" is not used in this way, but we assume

$$C_p°(C_4H_9SH) = C_p°(C_3H_7SH) + C_p°(C_5H_{12}) - C_p°(C_4H_{10}) + aT\exp(-bT)$$

$$S°(C_4H_9SH) = S°(C_3H_7SH) + S°(C_5H_{12}) - S°(C_4H_{10}) - \frac{a}{b}\exp(-bT) + \frac{a}{b} + c$$

$$\left(\frac{H° - H_o°}{T}\right)(C_4H_9SH) = \left(\frac{H° - H_o°}{T}\right)(C_3H_7SH) + \left(\frac{H° - H_o°}{T}\right)(C_5H_{12}) - \left(\frac{H° - H_o°}{T}\right)(C_4H_{10}) - \frac{1}{bT}\left\{aT\exp(-bT) + \frac{a}{b}\exp(-bT) - \frac{a}{b}\right\}$$

where $a = 5.399 \times 10^{-4}$ cal/mole °K², $b = 3.201 \times 10^{-4}$ 1/°K, $c = -0.217$ cal/mole °K are constants, which have been so chosen as to agree with the experimental values (see following table).

Calculated and Measured Properties of n-Butanethiol

Temperature °K	Measured[5] $C_p°$ cal/mole°K	Calculated $C_p°$ cal/mole °K	Temperature °K	Measured[5] S° cal/mole °K	Calculated S° cal/mole °K
400	34.98	34.98	330.62	92.71 ± 0.20	92.65
500	41.03	41.03	349.70	94.41 ± 0.20	94.41
			371.62	96.30 ± 0.20	96.33

This way of calculation has the advantage that the corrections to be added to the incremental values are smaller than those used in the U.S. Bureau of Mines calculations. The form of the correction function for the specific heat is such that this function vanishes for $T = 0$ and $T = \infty$. The thermodynamic properties found in this way are more in line with the thermodynamic properties of the normal alkanes, as can be seen when calculating the differences in the properties per —CH_2- group for the whole series in the temperature interval 273.15 °K . . . 1000 °K.

The thermodynamic properties of n-butanethiol are presented in Tables 3, 4, 5 and 6. Though the values given in this article do not differ much from the values for n-butanethiol published by the U.S. Bureau of Mines group,[5] the author believes that the values given here are more consistent with the values known for the normal alkanes.[18]

The Higher Homologs. Thermodynamic properties of the higher homologs were calculated with an ordinary method of increments, i.e.

TABLE 7

Compound	TEMPERATURE °K										
	0	273.15	298.15	300	400	500	600	700	800	900	1000
	Heat of formation ΔH_f° kcal/mole										
CH_3SH	—18.42	—20.70	—20.89	—20.91	—21.63	—22.26	—22.78	—23.20	—23.53	—23.79	—23.91
C_2H_5SH	—22.57	—26.31	—26.60	—26.62	—27.67	—28.64	—29.24	—29.78	—30.17	—30.45	—30.59
$n\text{-}C_3H_7SH$	—26.32	—31.23	—31.61	—31.63	—33.02	—34.16	—35.05	—35.70	—36.14	—36.23	—36.32
$n\text{-}C_4H_9SH$	—29.88	—35.99	—36.44	—36.46	—38.16	—39.53	—40.60	—41.38	—41.87	—42.14	—42.16
$n\text{-}C_5H_{11}SH$	—34.92	—41.32	—41.86	—41.89	—44.01	—45.54	—46.81	—47.72	—48.32	—48.63	—48.68
$n\text{-}C_6H_{13}SH$	—37.52	—46.02	—46.64	—46.68	—49.03	—50.90	—51.37	—53.43	—54.12	—54.49	—54.55
$n\text{-}C_7H_{15}SH$	—41.16	—50.85	—51.57	—51.61	—54.21	—56.41	—58.08	—59.29	—60.07	—60.49	—60.57
$n\text{-}C_8H_{17}SH$	—44.81	—55.70	—56.50	—56.54	—59.52	—61.92	—63.79	—65.14	—66.02	—66.50	—66.59
$n\text{-}C_9H_{19}SH$	—48.45	—60.54	—61.42	—61.47	—64.77	—67.42	—69.50	—70.99	—71.96	—72.50	—72.61
$n\text{-}C_{10}H_{21}SH$	—52.10	—65.98	—66.35	—66.41	—70.03	—72.93	—75.21	—76.85	—77.91	—78.50	—78.64

TABLE 8

Compound	TEMPERATURE °K										
	0	273.15	298.15	300	400	500	600	700	800	900	1000
	Free enthalpy of formation ΔG_f° kcal/mole										
CH_3SH	—18.42	—12.66	—11.92	—11.86	— 8.72	— 5.44	— 2.02	1.48	5.10	8.61	12.22
C_2H_5SH	—22.57	—12.15	—10.84	—10.74	— 5.29	0.40	6.26	12.29	18.24	24.32	30.40
$n\text{-}C_3H_7SH$	—26.32	—10.88	— 9.01	— 8.84	— 1.06	7.06	15.38	23.84	32.38	40.95	49.66
$n\text{-}C_4H_9SH$	—29.88	— 9.34	— 6.88	— 6.69	3.54	14.08	24.90	35.88	46.94	58.05	69.21
$n\text{-}C_5H_{11}SH$	—34.02	— 8.40	— 5.43	— 5.17	7.38	20.40	33.71	47.20	60.78	74.45	88.14
$n\text{-}C_6H_{13}SH$	—37.52	— 6.83	— 3.27	— 3.00	11.92	27.37	43.17	59.19	75.30	91.52	107.76
$n\text{-}C_7H_{15}SH$	—41.16	— 5.39	— 1.26	— 0.95	16.35	34.26	52.56	71.10	89.75	108.53	127.33
$n\text{-}C_8H_{17}SH$	—44.81	— 3.96	0.74	1.11	20.78	41.14	61.94	83.01	104.20	125.53	146.89
$n\text{-}C_9H_{19}SH$	—48.45	— 2.52	2.75	3.16	25.21	48.02	71.32	94.92	118.65	142.54	166.46
$n\text{-}C_{10}H_{21}SH$	—52.10	— 1.09	4.76	5.21	29.64	54.90	80.70	106.83	133.10	159.55	186.03

$$\Phi(C_nH_{2n+1}SH) = \Phi(C_{n-1}H_{2n-1}SH) + \Phi(C_{n+1}H_{2n+4}) - \Phi(C_nH_{2n+2}) \quad (n \geq 5)$$

where $\Phi = C_p^\circ, S^\circ$ or $\left(\frac{H^\circ - H_o^\circ}{T}\right)$

Thermodynamic properties thus calculated are compiled in Tables 3, 4, 5 and 6.

Heats of Formation and Free Enthalpies of Formation as a Function of Temperature

Starting with values of $\left(\frac{H^\circ - H_o^\circ}{T}\right)$ and $\left(\frac{G^\circ - H_o^\circ}{T}\right)$ given in Tables 4 and 5 we calculated ΔH_f° and ΔG_f° for the reaction

$$nC\ (gr) + (n+1)\ H_2\ (g) + \tfrac{1}{2}\ S_2\ (g) \rightarrow C_nH_{2n+1}SH\ (g)$$

using the heat of formation at 298.15 °K presented in Table 1. The enthalpy and free-enthalpy function of C (gr) and H_2 (g) were taken from the well-known A.P.I. publication;[13] the corresponding functions of S_2 (g) are those of Evans and Wagman.[14] The values of ΔH_f° and ΔG_f° for the normal gaseous alkanethiols are given in Tables 7 and 8.

Using contributions for hydrocarbon groups,[15] the contribution to the free enthalpy of formation of a primary —SH group can be calculated from the values of Table 8.

$$\Delta G_f^\circ = -11.827 + 0.975 \times 10^{-2}T \quad (300\ °K \ldots 600\ °K)$$

$$\Delta G_f^\circ = -11.815 + 0.973 \times 10^{-2}T \quad (600\ °K \ldots 1000\ °K)$$

(In order to retain internal consistency with the correlation published formerly,[15] the constants in this formula are given to more decimal places than is justified by the accuracy of the calculation).

With the help of the above formula and the correlation mentioned before, the free enthalpy of formation of the gaseous n-alkanethiols, beyond ethanethiol, can be calculated with an accuracy of ± 0.7 kcal/mole (max. dev.) and ± 0.2 kcal/mole (av. dev.)

Keywords for Indexing

Alkanethiols
Data
Energy
Enthalpy
Formations
Gases
Sulfur
Thermodynamics

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A Look at Today's Rigging Techniques for Process Plants

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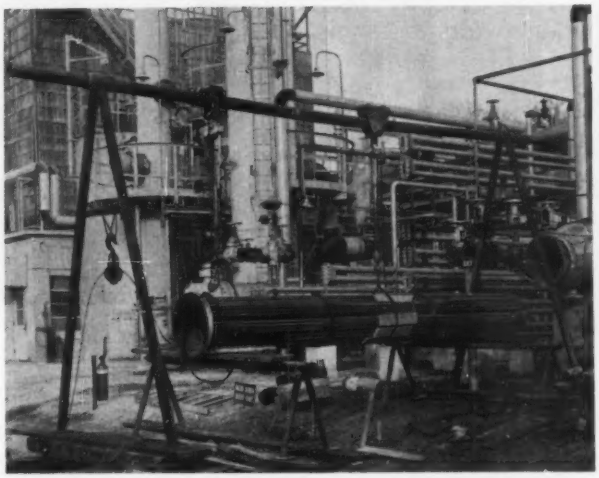


FIGURE 1—A-frame makes easy work of pulling reboiler bundle.

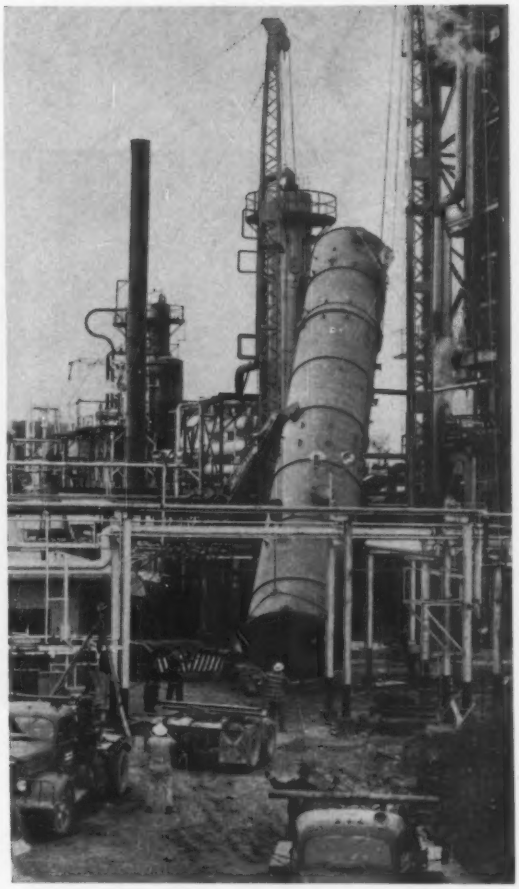


FIGURE 2—Two gin poles lift a 57,000 pound synthetic tower.

A basic skill such as rigging requires the application of sound engineering principles and Yankee ingenuity. These examples show you how it is done

One of the basic skills used in modern maintenance and construction is that of rigging. One which is so basic that most craftsmen little realize they are doing rigging when they use a chain puller, commonly called a comealong, to lift a valve into place or use a manila rope to pull a board up on a scaffold. Yet because rigging is so basic, little thought is given to the equipment and techniques used. Frequently very heavy, time consuming tackle is installed when lighter equipment could be used. Conversely, there are times when the load is dropped because the tackle is too light and gives away.

A-Frame Bundle Puller. Among refinery personnel there is considerable discussion as to which is used more in rigging, the chain hoist including comealongs or manila rope. This controversy would be hard to settle. Both are indispensable. Figure 1 shows two, three-ton comealongs used in conjuction with a portable A-frame to pull a reboiler bundle. A chain hoist would probably have been more convenient to operate, but since our refinery has standardized on 3-ton aluminum pullers with 12 feet of chain weighing approximately 40 lbs. each, the craftsmen prefer them. These vertical pullers are even more useful when used in conjunction with other refinery fabricated rigging aids such as the A-frame shown in Figure 1. This frame is made of 3-inch and 4-inch scrap pipe. The top monorail consists of a 3-inch, schedule 80 pipe slipped inside of a 4-inch, schedule 80 pipe and securely welded at each end. To make the A-frame readily portable, each end is separate. The top member of each end through which the 4-inch pipe slides, is a piece of 5-inch,

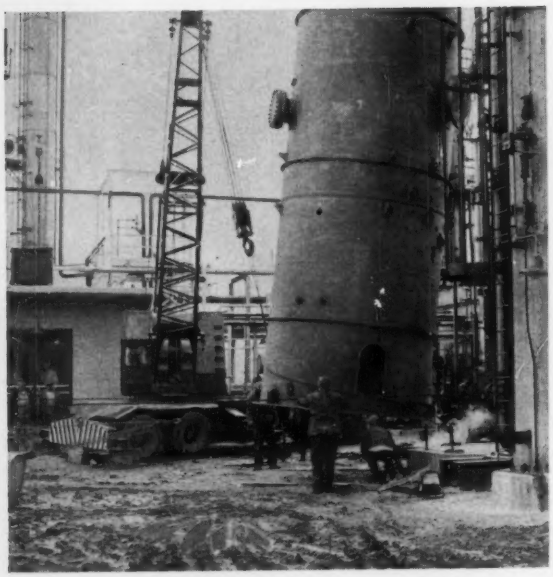


FIGURE 3—Tower about to be pulled into position for lowering.

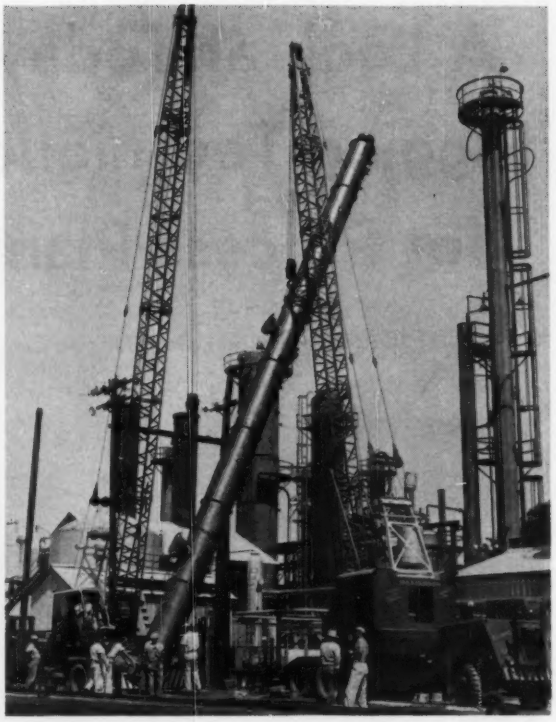


FIGURE 4—Cranes are used to set lighter towers.

schedule 80 pipe approximately 12 inches long. Although this sleeve has set screws in the top, they rarely need to be tightened. The craftsmen depend on the spread of the frames to lock the top monorail in position. Please note that on the monorail are two dollies to which the comealongs are attached.

For those refineries without extensive mobile hoisting equipment, such as crains, an arrangement such as described above is very helpful for general maintenance when pulling tube bundles as shown, repairing engines in the shop (especially useful when mounted on dollies), repairing cooling tower gear boxes and pumps and numerous other jobs.

Testing Chain Hoists. A word of caution about using chain hoists or chain of any kind. They, like all other rigging equipment, can be overloaded. Not only will they fail from being overloaded, but hoist chains will wear out. For safety's sake, a chain hoist test rig should be constructed. One which consists of a spring scale or load cell and some sort of frame long enough so that all of the chain will be tested and not just a short portion. A test rack of this type is more convenient to use if horizontal rather then vertical.

RIGGING FRACTIONATING COLUMNS

Perhaps the most difficult rigging job encountered in an oil refinery is that of standing fractionation columns on their foundations. Figure 2 shows two steel gin poles being used to lift a 10-foot ID x 60-foot (over-all height) synthetic tower weighing approximately 57,000 pounds. In this photograph, you will note that the load lines from the top of each gin pole are attached through shackles to a cable which was wrapped several times around the tower. Closer inspection will show that this cable is placed above the center line of the tower in order to be above the tower's center of gravity and is placed just below a nozzle to prevent it from slipping.

Had the gin poles been taller, we could have rigged from lugs on top of the tower. The advantage of rigging to a cable as shown, allows you to use shorter gin poles and to set towers which are taller than the poles. In this photograph, you will note that the gin poles are perpendicular. They could have been drifted over if required, but were not. Had they been drifted any great extent, the problem of tieing off their bases to keep them from skidding would have been encountered.

Raising the Tower. In raising the tower, the bottom was supported by a 25-ton crane equipped with a short boom. As the tower top was raised, the bottom section was kept just off the ground by the crane booming up and around.

The two winch trucks in the foreground of Figure 2 are being used to power the load lines on the two gin poles. A third truck not shown was being backed into position at the time of this photograph to act as a tag line on the base of the tower to prevent it from moving too fast. Figure 3 shows the tower suspended in the air and about to be pulled into position for lowering.

It may be of interest to note that the dead men to which the gin pole guy lines were attached consisted of

railroad crossties buried six feet deep. For safety, two ties were buried in each hole.

Setting Light Towers. For setting lighter towers when gin poles are not available, two cranes such as shown in Figure 4 raising a 3-foot ID x 78-foot over-all length primary absorber may be used. Had this tower been larger and heavier, the booms of the two cranes could have been stood vertically and guyed, then used as self-powered gin poles as previously outlined.

Using a Crawler. Figure 5 shows a single, large 50-ton crawler crane setting a 4-foot ID x 78-foot depropanizer column. The day before it had set the 4-foot ID x 95-foot isostripper column in the background. Both towers were raised in the same manner. The isostripper still has the lifting cables wrapped around its upper portion. Note the 2x4 pine boards used to protect the cable as well as to increase friction to prevent the cable from slipping up the tower since no nozzles were in the vicinity of the cable. The winch truck shown in the lower right hand corner is carrying the base of the depropanizer.

In Figure 5, you will note that the top platform is on the isostripper. This platform was installed while the tower was lying down. The boom of the crane was not tall enough to set it after the tower was upright. Also, it is less costly to install such platforms on the ground than in the air. The only danger to this procedure is that the platform can be easily crushed if the tower is not raised properly.

Inspection of the boilers at the time of purchase showed the drums and tubes to be in excellent condition. There was no reason to cut the tubes unless the boilers could not be moved to Memphis by a route which would provide proper railroad clearance. This routing was worked out with one exception, providing the drums were shipped in an upright position on the car. This one exception was at a point approximately one-half mile from the refinery where the railroad tracks pass under a railroad viaduct. Because of this, the boilers had to be unloaded at a site three miles from the refinery and loaded on a lowboy trailer and trucked to the refinery.

The problem that made this job so ticklish was that at no point in the entire moving job could the drums be set down except on the ends nor could they be jarred as either could crush the bottom tubes or loosen tubes to such an extent that they would have to be replaced. Needless to say, the job was completed with no damage to the boilers. The boilers were picked up by two cranes as shown, and rigged so that they were at a balance point. The side steel support beams were shipped attached to the two upper drums and the mud drum was also firmly anchored to this beam. After the unit was in the air, it was turned over in its present position by means of a winch truck which is seen in the foreground.

Setting Boiler Drums and Tubes. Another interesting rigging job is that shown in Figure 6. This figure shows two, 25-ton cranes being used to set the drums and tubes of a 425-HP water-tube boiler. In the background, directly behind the boiler being set, is a twin unit. These two boilers were old coal-fired boilers purchased used.

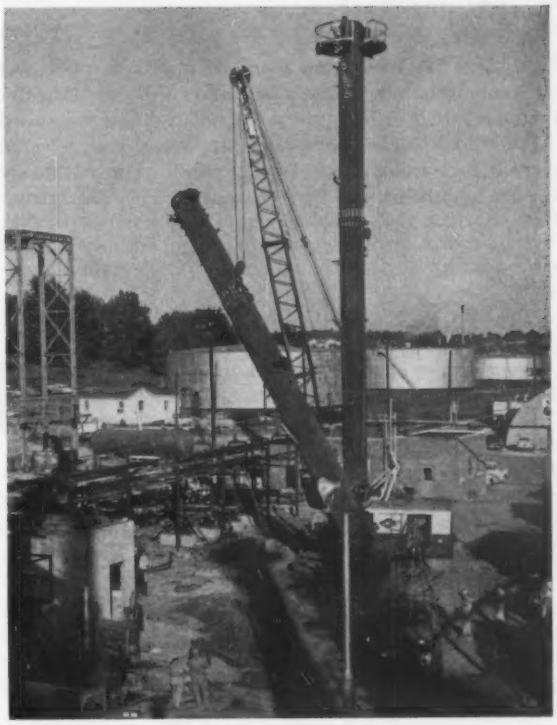


FIGURE 5—A 50-ton crawler sets this 78-foot depropanizer column.

FIGURE 6—Two 25-ton cranes are used to set the drums and tubes of a water-tube boiler.

This truck is now setting steel under the drums while the cranes are holding the unit in proper position.

Chicago Boom Versatile Rigging Tool. Figure 7 shows another versatile tool used on construction jobs. This so-called "Chicago Boom" is being used to field erect a shop fabricated catalyst storage drum. The 12-

foot ID x 120-foot drum made of half inch plate was too large to be shipped as a unit. You will note that this boom is "alive." Not only can the load line be raised and lowered but the boom also can be raised or lowered as well as swiveled around in its saddle. The advantage of this type boom can be readily seen. The TCC structure to which it is attached serves as the mast. All that is required is a relatively light boom and we have a strong lifting device taller than any crane readily available.

A boom similar to that shown in Figure 7, with a proper base, could be used as a gin pole.

Another use of a Chicago boom is shown in Figure 8. In this case, the 5-foot ID, tar-flash tower was carrying over and we needed to replace it with one 10 feet in diameter and one which had more disengaging height. As you can see from Figure 8, the location was inaccessible from the ground. In the foreground can be seen the top of a boiler, to the right numerous pipes, in the background the TCC structure and to the left not seen in this photograph are two large turbine-driven, centrifugal blowers. Not only was this location inaccessible from the ground but because of process arrangements and the time and cost of relocating the tar-flash tower, it was mandatory that the new top section be installed in the location shown. As a result, the bottom section of the old tar-flash tower, consisting mainly of a small diameter tub complete with float chamber, bottom head and skirt of the old vessel and a short section of the old shell, was strengthened to support the new top and the old top cut off. The new 10-foot top weighing nearly eleven tons was picked up by the 25-ton crane shown just to the left of the Chicago boom, handed to the Chicago boom in mid-air and the boom then swiveled around to lower the top into place. The draw works of the crane shown at the extreme left was used to supply power to the Chicago boom.

It is interesting to note that the boom shown in Figure 7 was not available for use in setting the tar-flash top and that the Chicago boom shown in Figure 8 is in reality the boom off of a 25-ton crane with a special base section.

Design Cuts Rigging Costs. Many rigging jobs can be facilitated by good design. As an illustration, Figure 9 shows a view of a Socony Model 17 TCC unit. This structure illustrates good, economical design with due care given to the lifting of the various vessels. In the design of the structure, the major platforms which surround the various vessels are independent of the vessels. These platforms are supported from the structural steel rather than from the vessels. This arrangement permits the erection of the structural steel with adequate platforms before atempting to life any of the vessels. As an illustration, the separator surge drum shown in the top of the structure is 6-feet, 11-inches ID x 28 feet and weighs over 27,000 pounds. Its top is more than 200 feet above the ground. It is supported by eight lugs attached to the shell near the bottom. The beams which support the vessel are attached to the third horizontal beam down from the top of the structure. In lifting the drum, four lines from the structure columns were attached to it just above the center line and the vessel lifted through the center of the structure before any other vessels were installed below. The drum was lifted slightly above its present position and held there while the beams on which it sits were riveted in place.

Figure 10 shows a close-up view of the top of the structure. In this picture you will note that the structure has been extended 16 feet and that a traveling bridge has been installed on top. This was done in order to change the vessel internals when the lift system was increased from one of 85 tons per hour to one of 330 tons

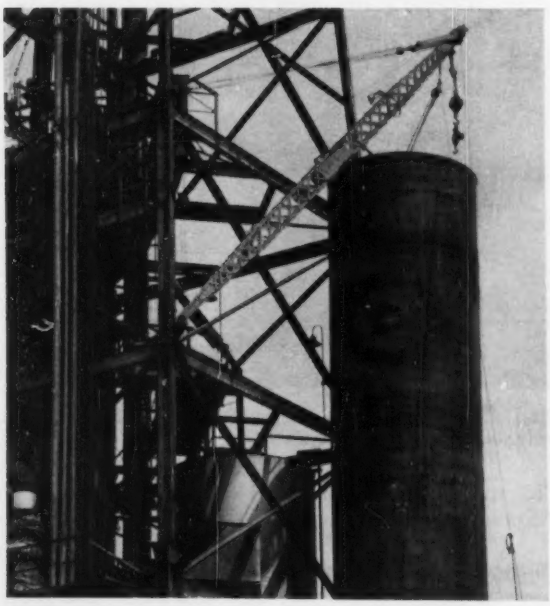
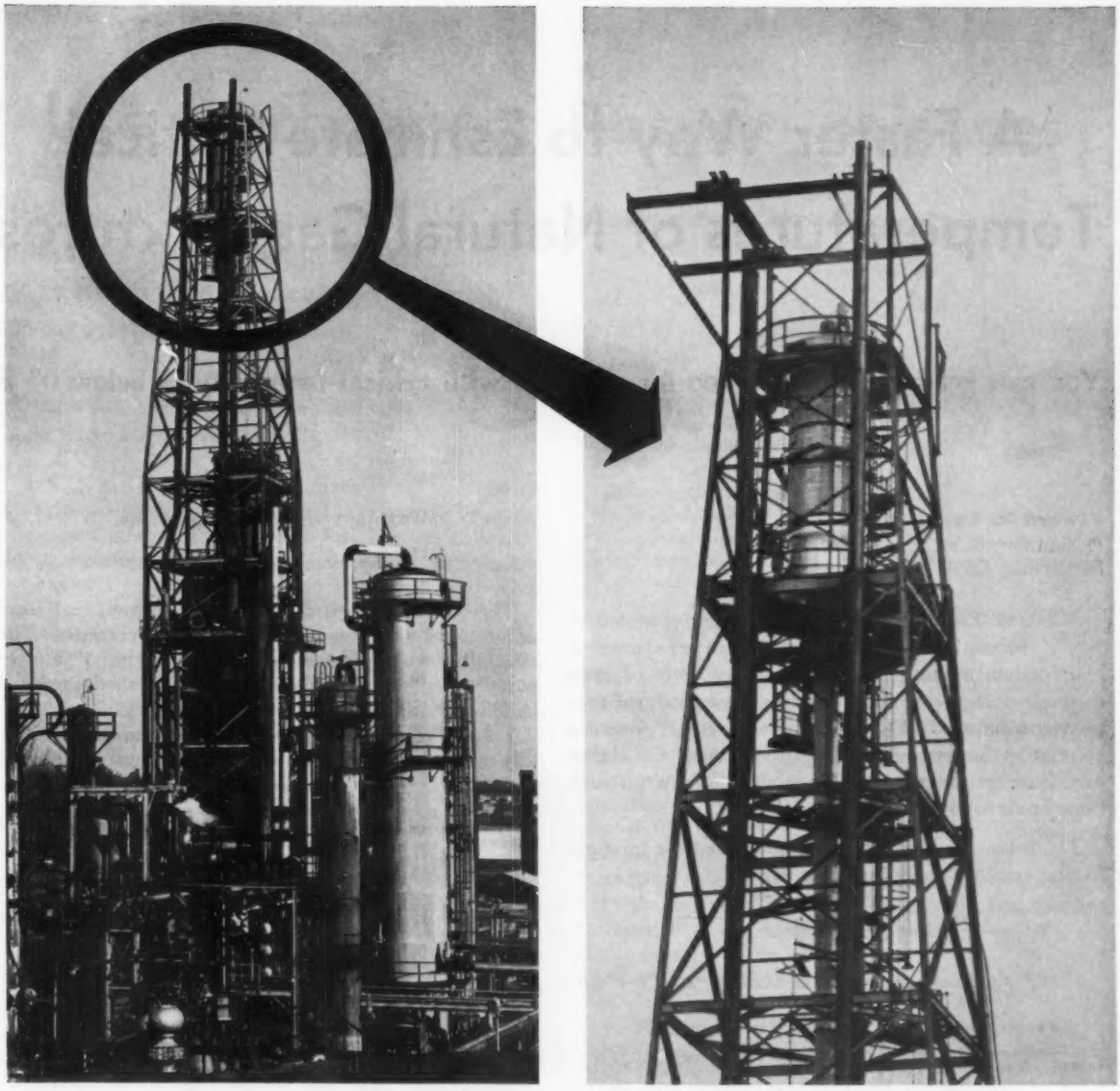


FIGURE 7—A Chicago boom attached to the TCC structure erects a catalyst storage drum.

FIGURE 8—Chicago boom used here to set tar-flash tower top is in reality boom off of a 25-ton crane with special base.



FIGURES 9 and 10—Structure on this TCC unit permitted lifting of separator surge drum through center of the structure.

per hour. It was calculated that it would require less downtime to cut the top off of the surge drum and drop the internals in from the top than it would to put them in small sections and weld them together. As it turned out, the shell of the vessel had eroded through in several spots and also had to be replaced.

Good Rigging is merely the application of sound engineering principles and the application of Yankee ingenuity. Should it be enhanced by a little experience, so much the better

Key Words for Indexing

Rigging
Lifting
Hoists
Chains
Towers
Columns (process)
Poles
Cranes
Trucks
Deadmen
Guying
Boilers

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A Faster Way to Estimate Critical Temperatures of Natural Gas Mixtures

You can get high accuracy too for mixtures with critical temperatures below 0° F

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A NUMBER of correlations have been proposed,[2, 3, 4, 5, 6, 7] for estimation of critical temperatures of hydrocarbon mixtures. Unfortunately, most of these methods do not extend to mixtures having critical temperatures below 0° F (460 R). Davis, et al[2] present a correlation for very volatile mixtures. Their calculation procedure is cumbersome and needs constants for each binary pair in the mixture.

The following equation is recommended for mixtures having critical temperatures up to 0° F.

$$T_c' = \frac{xTc + mTc}{2} \text{ where}$$

T_c' = Critical temperature of mixture, °R (°F + 460)

xTc = Pseudocritical temperature of mixture, °R

$$= \sum_{i=1}^{i=n} (\text{mol fraction}_i)\ (\text{critical temperature}_i, °R)$$

mTc = Weight average critical temperature, °R

$$= \sum_{i=1}^{i=n} (\text{weight fraction}_i)\ (\text{critical temperature}_i, °R).$$

This method is rapid, convenient to use, and is as accurate as the more complicated procedures. The standard deviation, based on 11 mixtures, is 3.3° F compared to a 3.0° F deviation for the method proposed by Davis, et al.[2]

Table 1 shows the critical temperature obtained by this method as compared with experimental results and with results obtained by Davis, et al.[2]

ACKNOWLEDGMENT

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Key Words for Indexing:

Critical
Estimates
Hydrocarbons
Mixtures
Natural Gases
Temperature

TABLE 1—Comparison of Critical Temperatures

Mixture	1	2	3	4	5	6	7	8	9	10	11
Component, Mole Percent											
Carbon Dioxide	1.20	1.09	1.00	0.91	0.44	0.30	0.20	0.13	0.20	0.25	.....
Helium	.....	.....	.....	.....	.....	.....	.....	1.00	0.60	0.31	.....
Nitrogen	.....	8.84	16.11	24.41	.....	11.30	24.00	11.46	13.50	7.05	.....
Methane	90.89	82.86	76.25	68.70	96.68	85.80	73.64	76.65	75.15	85.32	82.13
Ethane	4.40	4.01	3.69	3.33	1.60	1.50	1.20	5.51	6.10	4.11	6.37
Propane	1.91	1.74	1.60	1.44	0.70	0.60	0.53	3.35	3.27	1.98	4.09
i-Butane	0.33	0.30	0.28	0.30	0.14	0.12	0.10	0.35	0.38	0.37	0.50
n-Butane	0.60	0.55	0.51	0.40	0.20	0.18	0.15	0.90	0.60	0.39	1.85
i-Pentane	0.21	0.19	0.18	0.16	0.07	0.06	0.05	0.17	.....	.....	0.55
n-Pentane	0.13	0.12	0.11	0.10	0.05	0.04	0.04	0.15	0.20	0.22	0.67
Hexanes	0.15	0.14	0.12	0.11	0.05	0.04	0.04	0.33	.....	.....	1.03
Heptanes+	0.18	0.16	0.15	0.14	0.07	0.06	0.05		.....	.....	2.81
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Experimental Critical Temp. °R	381	368	356	340	359	343	329	376	370	364	460
Calculated Critical Temp. °R											
This Method	388	370	357	341	360	341	321	377	368	364	470
Davis, et al.	376	367	358	345	362	341	329	379	367	361	470 †

Experimental and calculated results for mixtures 1–10 are those reported by Davis, et al.[2] The experimental critical temperature for number 11 is reported by Allen.[1]
In calculating critical temperature, the properties for n-octane were used for the heptanes plus fraction.

Use Fractions for Recycle Balances

Additional formulas are presented for estimating the fractions of individual components separated by several types of operations

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HERE ARE some general methods for calculating more complicated recycle material balances. To make these methods more useful some formulas are presented for estimating the fractions of individual components separated by operations of several types. The author has found that these expressions are often useful for calculations other than for recycle material balances because they are in general simpler than conventional algebraic expressions.

Recycle material balance calculations may be simplified considerably by the use of a fraction separated method described in Part 1.

The key to the calculation is in expressing the amount of each component which is separated or converted by each step or operation as a "fraction separated," i.e., the fraction of a component removed by an absorber, the fraction converted in a reactor, the fraction condensed in a partial condenser, etc. These fractions always refer to the amount of each component being fed to the particular operating unit, for example, the fraction of a given component in an absorber feed which is absorbed and leaves in the rich oil.

GENERAL SOLUTION TO RECYCLE PROBLEMS

More complicated recycle problems can be solved by fairly simple general procedure. To illustrate, let's take three recycle situations, Figures 2, 3 and 4, representing a combination of separators or similar units. The first is the simple basic recycle used in the propane dehydrogenation example with a single "recycle loop," (see Part 1).

The other two examples have more complicated "overlapping" recycle loops. Now let's define two expressions.

M = A **main process flow expression.** This is equal to the pounds of a single component passing through the entire system per pound of fresh feed, **ignoring all recycles.** The main process flow is chosen so that all recycles are **reverse recycles** to this main flow stream.

R = A **recycle loop expression.** This is equal to the pounds of a single component recycling back to the feed of a particular recycling unit per pound of feed to the unit, ignoring the main stream flow **and** all other recycles.

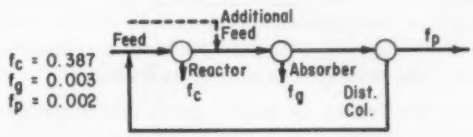
The over-all fraction of a component passing through the entire system of recycles is given by,

$$f_n = \frac{M}{1 - \sum_{i=1}^{i=n} R_i + \sum_{i=1}^{i=m} A_i - \sum_{i=1}^{i=o} B_i + \dots} \qquad (7)$$

where*

A = the product of recycle expressions for pairs that do not overlap
B = the product of recycle expressions for triplets that do not overlap
R = recycle loop expression, as defined above
n = total number of recycle loops associated with the main process flow
m = the total number of all possible **non-overlapping triplets** of recycle loops
o = the total number of all possible **non-overlapping triplets** of recycle loops

Use of this equation is illustrated in the calculations accompanying Figures 2, 3 and 4. It is evident that once the outlet flow rate is calculated all other streams may be determined by progressing backwards through the system—this is shown on Figure 4. It is further evident that an additional fresh feed introduced into any part of the system can be considered an independent main flow stream with its own associated recycles. Quantities calculated are simply added to quantities from the first feed—this is illustrated in the propane example; Figure 2, assuming that some propane is fed at the reactor outlet.



Propane

$M = (1 - f_c)\ (1 - f_g) f_p = (0.613)\ (0.997)\ (0.002) = 0.00122$

$R_1 = (1 - f_p)\ (1 - f_c)\ (1 - f_g) = (0.998)\ (0.613)\ (0.997) = 0.609$

fraction through $= M/(1 - R_1) = (0.00122)/(0.391) = 0.00312$

Additional propane feed

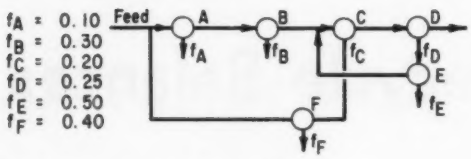
$M = (1 - f_g)\ (f_p) = (0.997)\ (0.002) \sim 0.002$

$R_1 = (1 - f_p)\ (1 - f_c)\ (1 - f_g) = (0.998)\ (0.613)\ (0.997) = 0.610$

fraction through $= M/(1 - R_1) = (0.002)/(0.39) = 0.00513$

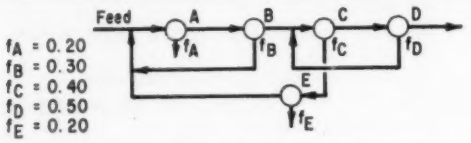
FIGURE 2—Simple basic recycle.

* Notes: 1. Non-overlapping recycles will **not** have any common terms in their recycle loop expressions, that is, the recycle flow loops will never flow through the same unit.
2. All possible recycles must be used, but a **complete** recycle loop may **not** be repeated in an expression of a second recycle loop.



$M = (1 - f_A)\ (1 - f_B)\ (1 - f_C)\ (1 - f_D) =$
$(0.90)\ (0.70)\ (0.80)\ (0.75) = 0.378$
$R_1 = f_C(1 - f_F)\ (1 - f_A)\ (1 - f_B) =$
$(0.20)\ (0.60)\ (0.90)\ (0.70) = 0.0757$
$R_2 = f_D(1 - f_E)\ (1 - f_C) = (0.25)\ (0.50)\ (0.80) = 0.100$
fraction through $= M/(1 - R_1 - R_2) = 0.378/(0.8243) =$
0.458

FIGURE 3—Two overlapping recycles.



$M = (1 - f_A)\ (1 - f_B)\ (1 - f_C)\ (1 - f_D) =$
$(0.80)\ (0.70)\ (0.60)\ (0.50) = 0.168$
$R_1 = f_B(1 - f_A) = (0.30)\ (0.80) = 0.240$
$R_2 = f_C(1 - f_E)\ (1 - f_A)\ (1 - f_B) =$
$(0.40)\ (0.80)\ (0.80)\ (0.70) = 0.1792$
$R_3 = f_D(1 - f_C) = (0.50)\ (0.60) = 0.300$
fraction through $= M/(1 - R_1 - R_2 - R_3 + R_3R_1)$
fraction through $= (0.168)/(0.352) = 0.476$

Assuming 100 pounds fresh feed
leaving in main stream = 47.6 lbs
feed to D = (47.6)/(0.50) = 95.2 lbs
recycle from D = 47.6 lbs
feed to C = (95.2)/(0.60) = 158.6 lbs
recycle from C = 63.4 lbs
feed to B = (158.5-47.6)/(0.70) = 158.5 lbs
recycle from B= 47.5 lbs
feed to A = (158.5)/(0.80) = 198.1 lbs

FIGURE 4—Three recycles—two not overlapping.

Note that the expressions M and R can be written easily from inspection of the flow diagram. Practically speaking, the procedure would be as follows:

1. Draw the system on paper, preferably accentuating the main process flow. Draw in the recycles.
2. Each process unit will have a feed to it and two streams coming out of it. Put down the actual fraction of the feed going out of each unit.
3. Then calculate the main process flow expression, M, by starting with the fraction of the flow that goes through the first unit and multiplying successively by the fractions of the flow that pass through all the units in the main process flow.
4. Similarly, to calculate the recycle expressions, R, start with the fraction that is recycled and multiply successively by all the fractions passing through each unit until the original unit is reached.

When recycles are extremely complicated, Nagiev[11,12] has developed a system of simultaneous equations which require computer solution when more than about four separating units are involved. Chemical processes, however, can usually be broken down into parts no more complicated than the recycle system shown on Figure 4.

EXPRESSING PERFORMANCE OF UNITS IN TERMS OF FRACTIONS SEPARATED

Expressions are presented for the following common types of operations:

Reaction
Venting
Absorption and Stripping
Distillation
Partial Condensing and Flashing

Reaction. When a component passes through a reactor the **fraction separated** is merely the fraction converted. Happily, this fraction converted does not vary too much with changes in non-reacting components and usually is arbitrarily selected at a constant value, the catalyst volume and mass velocity are usually fixed or selected to give the desired conversion. The laboratory provides the conversion data. A typical figure may be $f_c = 0.22$, meaning 22 percent of a component was converted or disappeared while passing through the reactor.

Venting. The venting operation is simple. When a fraction of a stream is vented, the identical fraction of each component is vented. For example, if 1/10 of a recycle gas stream is vented ($f_o = 0.10$), precisely 1/10 of each of the components will appear in the vent stream.

Absorption and Stripping. The net amount of a compound that is absorbed or stripped in a column is a function of the vapor-liquid rates, physical equilibrium, and the number of theoretical stages. If one can use an effective KV/L (stripping factor) or L/KV (absorption factor), absorption and stripping factor charts make it simple to find the "fractions absorbed or stripped." These charts are merely a plot of the expressions derived by Kremser for absorbers and strippers.[1,4,10]

The fraction of a component absorbed in a column,

$$f_a = \frac{(L/KV)^{N+1} - (L/KV)}{(L/KV)^{N+1} - 1} \qquad (8)$$

The fraction of a component stripped in column,

$$f_s = \frac{(KV/L)^{N+1} - (KV/L)}{(KV/L)^{N+1} - 1} \qquad (9)$$

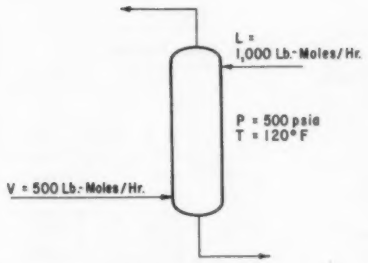
The reader is referred to the references cited (see Part 1) for the restrictions imposed by the derivation of the above equations.

The simplified treatment presented in the following examples for absorbers and strippers serves to illustrate methods for estimating the fractions removed. These fractions would be used in conjunction with the calculation of recycle material balances. It is recognized that more precise methods are required in some cases but the procedure will be about the same.

EXAMPLE 1

One thousand lb-moles of oil are used to absorb ethane from 500 lb-moles/hr of a gas containing 40 lb-moles of ethane. The tower has five theoretical stages. Please refer to Figure 5.

A more common installation is the absorber-prestripper combination, where the rich oil leaving the aborber



Calculation—Approximately $L/V = 1{,}000/500 = 2.0$; $K_{ethane} = 1.7$ at 120° F, 500 psia; $N = 5$; $(L/KV)_{ave} = 1.17$ (ethane); from absorption factor chart or equation (8); $f_a = 0.89$ (fraction of ethane absorbed); ethane absorbed $= 0.89\ (40) = 35.6$ lb-moles/hr.

FIGURE 5—Simple absorption of ethane from a gas stream.

is partially stripped with an inert gas and the stripped material is recycled into the absorber with the feed. It is convenient at this point to come up with an expression for the **over-all** performance of such an absorber and prestripper together. Let's call f_a' the fraction of a compound which is fed to the system that leaves with the bottoms from the prestripper, then

$$f_a' = \frac{1}{1 + \dfrac{(1 - f_a)}{(1 - f_s)f_a}} \quad \text{for vapor feed*} \qquad (10)$$

$$f_a' = \frac{1}{1 + \dfrac{(1 - f_a)f_s}{(1 - f_s)}} \quad \text{for liquid feed} \qquad (11)$$

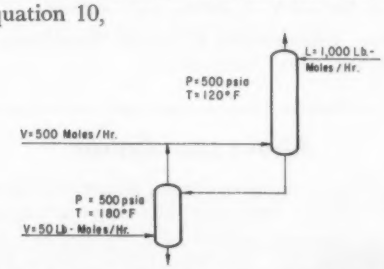
f_a = fraction of a component absorbed from vapor feed into the absorber

f_s = fraction of a component stripped from the rich oil into the prestripper

EXAMPLE 2

The same absorber is used as in Example 1, a prestripper now takes the rich oil and strips it with 50 lb-moles/hr of inert gas, what is the net ethane absorbed, f_a'? Please refer to Figure 6.

The net fraction of ethane absorbed is calculated from equation 10,



Calculation—Absorber: $L = 1{,}000$ lb-moles/hr; $V = 550$ lb-moles/hr (approximate); $K_{ethane} = 1.7$ at 120° F, 500 psia; (L/KV) average = 1.07; No. of theoretical stages = 5; $f_a = 0.86$.

Prestripper: $L = 1{,}000$ lb-moles/hr; $V = 50$ lb-moles/hr; $K_{ethane} = 2.2$ at 180° F, 500 psia; (KV/L) average = 0.110; No. of theoretical stages = 3; $f_s = 0.110$.

FIGURE 6—Same absorber as used in Example 1 except a prestripper now takes the rich oil and strips it with 50 pound moles per hour of inert gas.

$$f_a' = \frac{1}{1 + \dfrac{(1 - 0.86)}{(1 - 0.110)\ (0.86)}} = 0.845$$

Without this type of an algebraic expression for the absorber-prestripper, one might be inclined to calculate these columns by a trial and error procedure. The amount returned from the prestripper would be estimated, added to the feed vapor, and the amount absorbed determined. Then the amount stripped could be calculated and used to check and re-estimate the amount added to the feed.

In the case of a feed that is part vapor and part liquid, the calculation is done for the vapor part and the liquid part completely independently using equations (10) and (11) and the results combined. Note that the actual vapor-liquid loads in the column must be used for estimating the column performance.

EXAMPLE 3

In Example 2, assume that the feed is part liquid and that 10 of the 40 lb-moles/hr of ethane appear in the liquid portion of the feed; for the sake of expediency, assume vapor-liquid loads do not change. The fraction of ethane absorbed from the vapor portion of the feed f_a', has been found to be 0.845. The fraction of the liquid ethane absorbed is determined by equation (11).

$$f_a' = \frac{1}{1 + \dfrac{(1 - 0.86)\ (0.110)}{(1 - 0.110)}} = 0.988$$

Total absorbed $= 0.845\ (30) + 0.988\ (10) = 35.3$ lb-moles/hr

The over-all fraction absorbed,

$$f_a' = (35.3/40) = 0.883$$

In a somewhat more complicated case the rich oil from the absorber is preheated (usually with the stripper bottoms) and partially flashes on the top tray of the prestripper. This scheme is diagrammed in Figure 7 and equation (12) gives the over-all fraction absorbed from a vapor feed.

$$f_a' = \frac{1}{1 + \dfrac{(1 - f_a)}{(1 - f_s)f_a\ f_l}} \qquad (12)$$

f_a', f_a, are defined in previous examples

f_l = fraction of a component in the absorber bottoms **not flashed** (remaining in the liquid portion after the flash).

f_s = fraction of a component in the liquid prestripper feed which is stripped in the prestripper.

A method for estimating the term f_l is presented in a later section.

DISTILLATION

In a distillation column part of the overhead product is returned as reflux and part of the bottoms product is returned as reboil vapor. The fraction of a given compound in the feed recovered either in the overhead or bottoms does not vary greatly with changes in feed composition or rate provided the theoretical plates and

* These expressions are readily derived by the use of the recycle formulas presented earlier. Note: Ignore the oil and the stripping vapor streams.

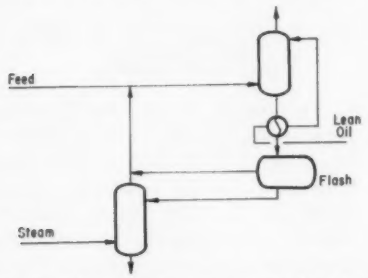


FIGURE 7—In this example, some of the feed is liquid, and stripper bottoms are used to preheat and partially flash the rich oil from the absorber.

reflux rate, expressed as a proportion of the feed, stay the same. This presumes a constant relative volatility and equimolar liquid and vapor rates from top to bottom of the column.[5]

When a distillation operation occurs in a recycle system, a distillation calculation can be performed with an "approximate" feed composition and the fractions computed. These fractions will not vary greatly with changes in feed composition and rate provided the total reflux rate is adjusted so that L/F stays the same.

PARTIAL CONDENSING AND PARTIAL FLASHING

If one has an estimate of the fraction of the total vapor stream that is condensed in a partial condenser the fraction of a given component appearing in the liquid phase is given by the equation:

$$f_l = \frac{f_L}{K - f_L(K-1)} \qquad (13)$$

where f_l = fraction of the individual component that appears in the liquid phase
f_L = fraction of the total feed stream that is condensed
K = equilibrium ratio for a given component at the equilibrium temperature and pressure

The analogous equation for the fraction in the vapor is,

$$f_v = \frac{f_V K}{1 + f_V(K-1)} \qquad (14)$$

Both of these equations are derived from the basic flash equations and are converted to the expressions which pertain to the individual components.

When only an estimate of the over-all f_L or f_V is available, the component fractions can be calculated. If component amounts condensed or flashed are added up, a new overall f_L or f_V is determined. Although convergence is obtained, it may be slow and other methods for convergence can be used.[8]

An example of the use of the flash equations is presented.

EXAMPLE 4

A hydrocarbon mixture is to be flashed into a vapor and liquid phase. It is estimated that about 15 mole percent of the feed will be vaporized, $f_V = 0.15$. What fraction of each of the components will appear in the vapor? The K-values at equilibrium conditions are as shown in Table 7.

Table 7

Flash Calculations

	Z_f	K	($f_V = 0.15$) $\frac{f_V K}{1 + f_V(K-1)}$	Check $f_v Z_f$
Ethane	0.03	5.0	0.469	0.0141
Propane	0.20	2.0	0.261	0.0522
Butane	0.37	0.97	0.1463	0.0541
Pentane	0.35	0.48	0.078	0.0273
Hexane	0.05	0.25	0.0423	0.0021
	1.00			0.1498

The third column of figures (Table 7) gives us the fraction of each individual component that appears in the vapor, for example, 46.9 percent of the ethane in the feed is flashed into the vapor or $f_v = 0.469$.

The important suggestion intended in the presentation of the preceding examples is that the equations for other special situations may be derived with not too much difficulty. The same types of expressions may be derived for liquid-liquid extraction and other two-phase mass transfer operations. The full utility of these "fractions" is realized in calculating complicated recycle material balances by the general method presented in Parts 1 and 2 of this article. The advantage is that the performance calculations for the various operating units may be made independently on any convenient basis, then the performance expressed in terms of "fractions separated." These fractions then are either constant or vary only slightly and may be used to compute the recycle material balance.

(Nomenclature and references appeared in Part 1)

Key Words for Indexing

Thermodynamics
Equilibrium
Recycle
Reactions
Venting
Absorption
Stripping
Distillation
Condensation
Flashing
Operations

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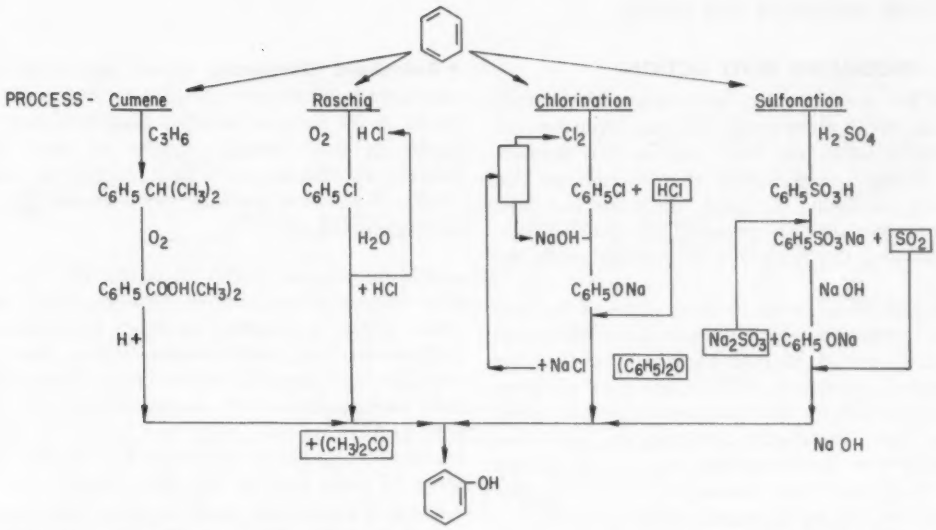
Vela



PROCESS	OTHER PRODUCTS OBTAINABLE
Cumeme	Acetophenone, ∝ Methyl Styrene, Acetone
Raschig	Dichlorobenzene, Diphenyls
Chlorination	Dichlorobenzene, Phenyl Phenols
Sulfonation	Sodium Sulfate, Sulfur Dioxide, Plenyl Phenols

□ MAIN BYPRODUCTS

FIGURE 1—These are the principal reactions in commercial phenol manufacture.

What Are the Processes and Prospects for Phenol?

Four established routes compete and growth patterns shift as new processes coming into the field make phenol more petrochemical

Joseph Gordon, Los Angeles

More need for phenol and more processes for its manufacture are pushing it steadily towards the center of the petrochemical arena. Starting with the advent of the cumene phenol process about seven years ago, the trend largely reflects its growing acceptance in competition with three other, longer-established processes.

Phenol-from-cumene now supplies about 21 percent of the total U.S. synthetic output, but this will be increased to about 25 percent before the end of next year. A two year phenol expansion program which began in 1960 will see phenol producers boosting their capacity some 30 percent, as U.S. phenol capacity reaches the billion lbs./year level.

Significant technical and regional trends further highlight this expansion spurt. Among them:

- Emergence of two new petrochemical processes in addition to cumene
- Process switching by the two largest phenol producers
- Regional shifts which include the second phenol unit on the Gulf Coast and the first in the Pacific Northwest.

Six of the nine major phenol producers are participants in this expansion, being either now engaged in or having recently completed, a substantial facility increase. They intend to stake out their claims to some phenol uses opening up. Much of their interest is whetted by relatively new phenol-derived plastics: epoxies, caprolactam and polycarbonates. Some will be counting on at least moderate gains from the phenolic resins, though more likely in bonding and coating applications than in molded products.

Still others expect to reap benefit from growth by alkylphenols in surfactants; by herbicides such as 2,4 D; by fungicides such as pentachlorphenol; and by numerous other uses to which phenol makes a contribution in one form or another.

PRODUCERS INTO ACTION

Producers are now stressing new uses and diversification so as to break away from their past over-dependence on phenolic resins, the No. 1 use for four decades. It has not escaped their notice that though molded products have continued to grow, the pace has been slowing and uneven due to increasing competition from thermoplastics and the fickleness of durable goods demand.

From the processing point of view, plans of the two largest phenol producers—Dow Chemical and Monsanto Chemical—hold special interest. Prominent as they are in petrochemical operations, neither has ever yet gone over to such processes for their large-scale phenol needs. Instead they have steadfastly continued to use other processes which they first developed years ago and kept improving. Now, each one, starting to build in a new location, has decided on a petrochemical process.

• **Dow Chemical,** the largest phenol producer, has been relying entirely on caustic hydrolysis of chlorobenzene, a process it successfully worked out in 1924. The plant at Midland, Mich. has steadily expanded, and with its most recent addition, late in 1960, has the whopping annual capacity of 235 million lbs., the world's largest by a wide margin.

Dow's second phenol plant is under construction in the Pacific Northwest at Kalama, Wash. This new unit of 36 million pounds/year capacity is a pioneering venture on two counts: It will be the first phenol plant in the area, and it will use a new oxidation process based on toluene. This two-step process is largely based on Dow's patents (U.S. 2,727,924 and U.S. 2,727,926), but will incorporate some technological know-how from California Research Corp. (U.S. 2,766,294).

When the plant goes onstream about the middle of next year, it will mark the debut of a second petrochemical route, as well as the fifth commercial phenol process in coexistence.

• **Monsanto Chemical,** next to Dow in phenol capacity, has since World War I days met its phenol requirements by the benzene sulfonation process. Historically, this was also the first commercial synthetic route, although the modern operation would show little resemblance except in principle to the original.

Monsanto has also decided to go petrochemical in phenol by construction of a cumene process facility as part of the newly-planned $75 million complex at Chocolate Bayou, Texas. Monsanto's new cumene unit will have a yearly capacity of some 75 million pounds of phenol and 45 million pounds of the co-product, acetone.

These upcoming petrochemically-oriented moves by the two largest phenol producers indicates clearly that in new facilities at new locations, the petrochemical approach exerts a powerful attraction which speaks well for its future. It does not necessarily follow, however, that it would be the choice in all circumstances.

On the contrary, petrochemical inroads will be strongly resisted by the other established processes, if the concurrent expansion agenda of other leading phenol producers is any criterion.

• **Reichhold Chemicals,** second largest in sulfonation, continues adding more capacity to its Tuscaloosa, Ala., plant. A 50 percent increase completed late last year boosts its total annual capacity to some 90 million pounds. Reichhold was also intending to build in the Pacific Northwest, but has been reconsidering since the Dow go-ahead there.

• More output is also slated by the two producers who employ a regenerative (Raschig-type) process, in which phenol is obtained by steam hydrolysis of chlorobenzene at high temperatures. These two producers are: Hooker Chemical, whose Durez Plastics Division—then independent—first commercialized the U.S. Raschig process around 1940; and Union Carbide, which developed a modified version and went into production some 10 years later at Marietta, Ohio.

Carbide's Marietta plant capacity has recently been upped from 85 million to 105 million pounds per year. Hooker is building a new Raschig plant slated for completion early next year at South Shore, Ky. Incorporating further process modifications based on Hooker's research, this unit will have an annual capacity of some 50 million pounds.

Among the four cumene phenol producers, Allied Chemical last fall doubled the capacity of its Frankford, Pa., plant, making its annual capacity nearly 100 million pounds, about twice the size of its closest present rival. Originally a sulfonation phenol producer, Allied switched over to its self-developed cumene process early in 1954. Practically all of Allied's output goes to Hopewell, Va., where it is used to make caprolactam (nylon 6).

Three other phenol producers also use the cumene route. They are: Hercules Powder, U.S. licensor of the Distillers Company Ltd. process; California Chemical's Oronite division, first West Coast producer; and Shell Chemical, whose Houston plant started up in 1959. (Table 1 gives the roster of phenol producers with plant locations and estimated capacities as of mid-1962.)

As expansions testify to growing phenol needs, so do

TABLE 1—U.S. Synthetic Phenol Production Capacity
(Estimated Mid-1962)

Producer	Location	Process	Million Lbs/Yr. Capacity
Dow Chemical....	Midland, Mich. Kalama, Wash.	Chlorination Toluene Oxidation	235 36
Monsanto Chemical.....	St. Louis, Mo. Avon, Calif. Chocolate Bayou, Tex.	Sulfonation Sulfonation Cumene	120 40 75
Allied Chemical...	Frankford, Pa.	Cumene	105
Hooker Chemical..	N. Tonawanda, N.Y. S. Shore, Ky.	Raschig Raschig	65 50
Union Carbide....	Marietta, O.	Raschig	105
Reichhold Chemical.....	Tuscaloosa, Ala.	Sulfonation	90
Calif. Chemical....	Richmond, Calif.	Cumene	45
Shell Chemical....	Houston, Texas	Cumene	40
Hercules Chemical.....	Gibbstown, N.J.	Cumene	25
		Total.....	1031

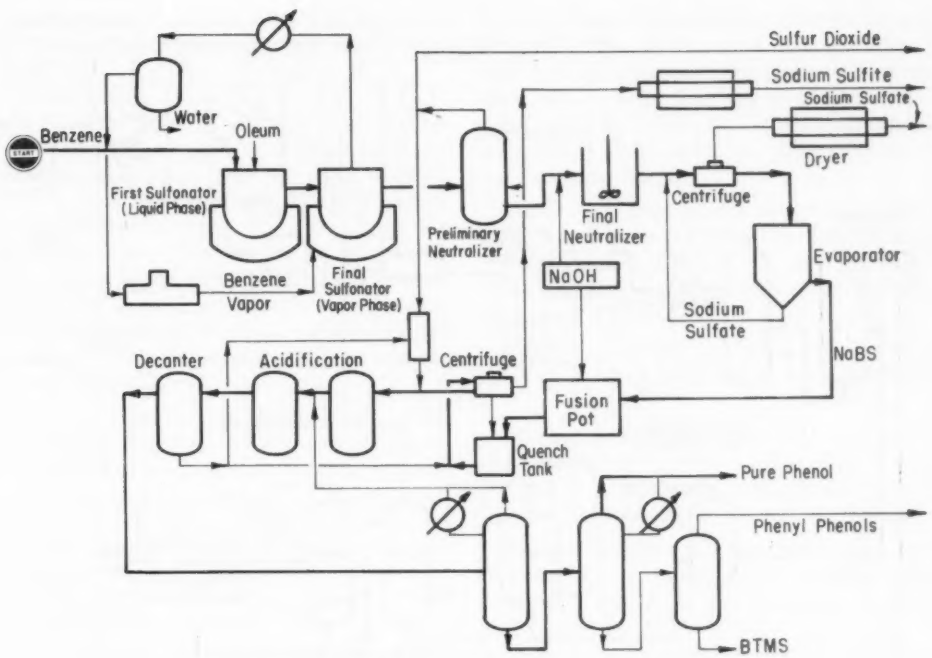


FIGURE 2—Two-step sulfonation process follows this general scheme.

the process shifts hint at the keen rivalry among the various ways of making it. When a producer is ready for expansion, he has to evaluate which process best suits his needs at a given time for a given location and for a given size of operation. Though the petrochemical way continues to gain ground, each process is well entrenched and each has particular conditions which favor it. Investment and production costs have stayed together quite closely, so that one deciding cost factor may tip the scales toward one, rather than another, process.

The processing concepts and operations will be more readily understood and evaluated by referring to the descriptions, reactions and flowsheets which follow. Figure 1 shows the principal reactions in the four phenol processes.

These processes have at least one similarity in common—the fact that they are all two-stage operations. In addition, similarities and contrasts between the chlorination and Raschig processes are interesting to note.

Unless otherwise noted, the process descriptions and flowsheets are intended to be typical rather than representing a specific operating plant. Some simplification has been introduced to emphasize the essentials, but more detailed data for several processes are provided in references listed in the bibliography.

SULFONATION PROCESS

Despite the appearance of complexity, the sulfonation process is quite straightforward in principle. (See Figure 2) Benzene is converted to phenol in two stages usually as follows:

1. Sulfonation of benzene produces benzene sulfonic acid (BSA), which is converted to the sodium salt (NaBS).

2. Caustic fusion of the NaBS produces sodium phenate, from which phenol is obtained on acidification ("springing").

Main byproduct of the fusion is sodium sulfite, part of which usually goes to neutralize the BSA, liberating sulfur dioxide. The latter can then be used to spring the phenol in the second step.

A variant of this procedure is to fuse the BSA with caustic directly, though the reaction is somewhat more difficult to control. In this case acidification of sodium phenate is ordinarily done with dilute sulfuric, resulting in sodium sulfate as a second major byproduct.

Sulfonation. Benzene sulfonation with sulfuric acid proceeds readily at moderate temperatures as long as the acid concentration exceeds 80 percent. But water formed in the sulfonation dilutes the acid and slows down the reaction. The principal means to drive the reaction to completion is to use oleum, though this requires cooling and close temperature control to prevent formation of undesired byproducts such as disulfonic acids and sulfones.

Monsanto's sulfonation technique calls for the use of six sulfonation reactors in series. The first reactor, where most of the heat is generated, requires both a water-cooled, jacketed reactor and a shell-tube heat exchanger; the second is also cooled; the remaining reactors use increasing amounts of heat to complete the reaction.

A second method of completing the reaction is to pass vaporized benzene through the sulfonation mixture, to sweep out water and make more acid available for

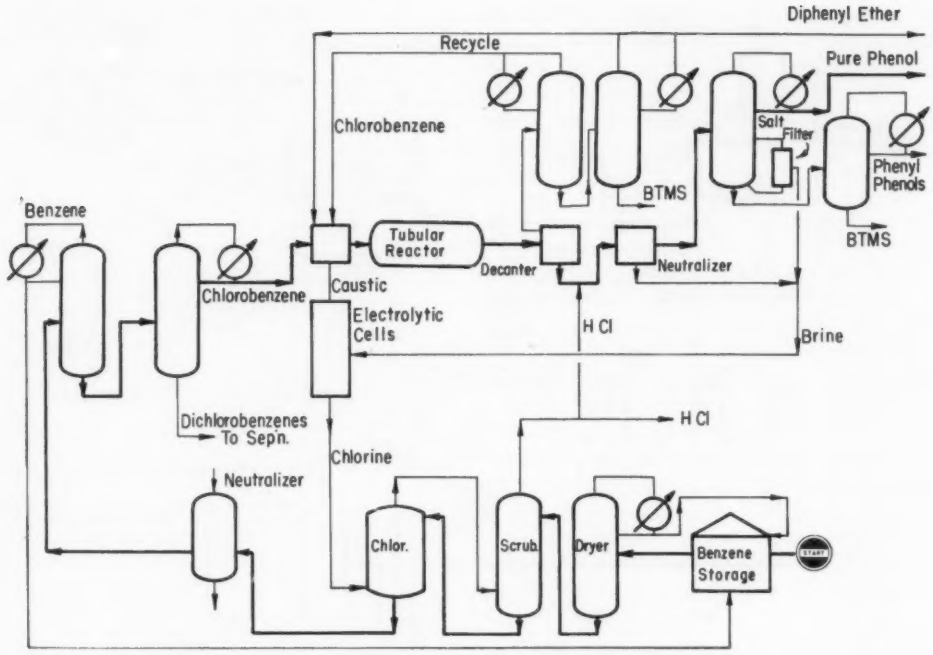


FIGURE 3—This reaction scheme produces phenol by chlorination.

sulfonation. On condensing, the vapors form two layers, permitting benzene to be seperated and recycled until the reaction is essentially complete.

The product leaving the sulfonator contains BSA and some unreacted sulfuric acid, depending on the degree of completion. Conventional practice calls for neutralization with part of the sodium sulfite from the fusion reaction. Neutralizing tanks are lead-lined due to the corrosiveness of the liberated sulfur dioxide, which is recovered for sale or use.

Neutralizing with dilute caustic forms a slurry which is cenrifuged to remove sodium sulfate. The centrifugate is a NaBS solution which is concentrated by evaporation, during which additional sodium sulfate separates and is fed back to centrifuging.

Fusion Operation. Fusion is done in gas-fired cast iron pots, equipped with agitation. Concentrated caustic (70 percent) goes in first, and is evaporated to dryness. The concentrated NaBS solution is added at such a rate that will maintain the mix in a fluid state. Additional heating is required after the NaBS has been added to insure completion of the fusion. The fusion mass, made up of sodium phenate and sodium sulfite, is quenched in a recycle wash liquor. Centrifuging separates the sodium sulfite, and the wash liquor returns to the quench tank.

The centrifugate is sodium phenate solution which is acidified to release the phenol. Generally at least part of this acidification is done with sulfur dioxide recovered from the first neutralization step, although dilute sulfuric is also used. The two-layered, acidified product is decanted: The aqueous layer returns to the phenate acidification and additional sulfite is recovered; the supernatant phenol layer goes on to purification, via a series of three fractionating columns:[1]

1. A dehydration column takes off a 10-15 percent phenol overhead which is returned to the phenate acidification.

2. The second column overhead is 70-75 percent phenol, recycled to the first column.

3. Bottoms from the second column goes to the finishing column which gives USP phenol as the final product.

Heavy ends including phenyl phenols and other products are usually separated in batch stills.

Materials of Construction. Cast iron is satisfactory for sulfonators and fusion pots, lead-lined tanks for neutralization and stainless for lines handling hot slurries. Carbon steel is used for fractionation except on the finishing column, where from the condenser to storage is nickel or nickel-lined.

CHLORINATION PROCESS

Dow's chlorination route to phenol as used at Midland consists of the following steps:

1. Benzene and chlorine react to give monochlorobenzene, together with HCl and about 5 percent polychlorbenzenes.

2. Monochlorobenzene is hydrolyzed with aqueous caustic to give sodium phenate, from which the phenol is obtained by acidification with HCl from the first step. Diphenyl ether is also produced in this step, and can be recycled to suppress additional formation.

Sodium chloride formed in the second step can then be electrolyzed to produce additional caustic and chlorine.

Chlorination. Benzene dried by azeotropic distillation is first used to scrub small amounts of chlorine from the byproduct HCl (See Figure 3). This partly-chlorinated benzene goes to the chlorinator where, in the presence of ferric chloride catalyst, it reacts with gaseous chlorine from the electrolytic cells. Temperature is maintained near the boiling point of benzene (80°C). The flow is regulated to give the desired reaction rate and maintain the desired proportion of mono- to polychlorinated product. According to the products desired, recycle usually varies from 30-50 percent.

Typical composition of the "chlorinated oil" is 30-50 percent unreacted benzene, 30-50 percent monochlorobenzene, and from 3-12 percent dichlorobenzenes. This product is first washed and then neutralized with dilute caustic. Fractionation is done with a series of bubble cap columns having the following number of plates: 7 to remove tars; 15 to strip off a 98 percent benzene overhead; 30 for the finishing column to take off the monochlorobenzene overhead. The bottoms is fractionated in a 12 tray column under 3 psia, giving additional monochlorobenzene in the overhead. Higher chlorinated products are also separated and recovered.[2]

Caustic Fusion. The monochlorobenzene with diphenyl ether recycle is mixed with dilute aqueous caustic, using from 2-2.5 moles of caustic per combined mole of chlorobenzene and diphenyl ether. This mixture at 4,000 psi is forced into a tubular steel autoclave. The reaction is started when external heating brings the temperature to about 340°C, after that, the exothermic reaction maintains itself near 375°C. Autoclave residence time usually varies from 10-30 minutes, depending on the recycle and products desired.

The reactor product is a two-phase system and separated in a gravity decanter. The heavier aqueous phase contains sodium phenate and sodium chloride; the oil phase contains unreacted monochlorobenzene, diphenyl ether and polyphenyls.

Distillation of the oil phase is accomplished in a series of columns as shown in simplified form in Figure 3.

Monochlorobenzene is recycled to the caustic fusion step. Part of the diphenyl ether is recycled and part is purified by crystallization. Much of it goes into a heat transfer fluid, which is 75 percent diphenyl ether.

The water phase is contacted with a small amount of benzene to extract dissolved organics, and then acidified with HCl from the first step to liberate phenol and phenylphenols.

Phenol Recovery and Purfication. In the decanter, two layers are formed: The upper layer containing phenol and the lower, dissolved NaCl. The phenol layer is distilled to remove the water azeotrope overhead. The bottoms after pumping through a salt filter, go to the finishing column which operates under vacuum

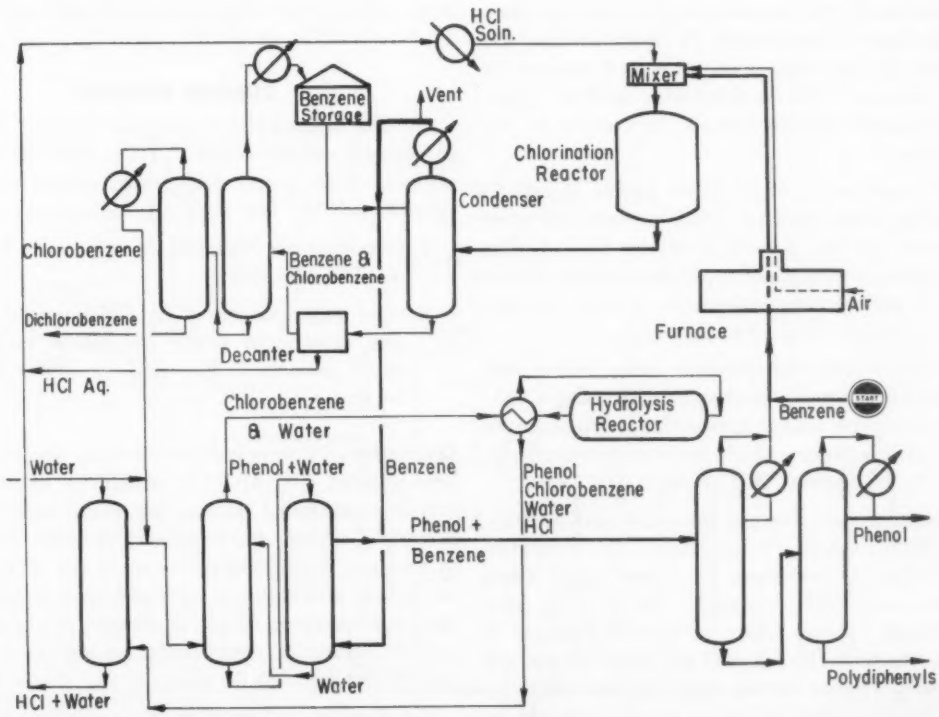


FIGURE 4—In this Raschig process, phenol is obtained from chlorobenzene, made from benzene and HCl.

(1.5 psia). Pure phenol in the overhead is stored in nickel or glass-lined tanks. Bottoms containing 85 percent phenyl phenols are separated in batch stills.

RASCHIG PROCESS

In this regenerative process (See Figure 4), phenol is obtained from chlorobenzene by hydrolysis with steam. The process consists of the following steps:

1. Benzene is chlorinated to monochlorobenzene with an HCl—air mixture by a modified version of the Deacon process. Chlorides of copper and iron catalyze the reaction, and conversion per pass is kept below 15 percent to avoid excessive polychlorination.
2. Monochlorobenzene is hydrolyzed with steam over a high-temperature catalyst to produce phenol, together with HCl for recycle to step 1.

Because of high temperatures and extensive use of wet HCl, corrosion has presented some serious problems. However these have mostly been solved by the use of acid brick and ceramic materials. Aside from the use of nickel-molybdenum alloys in a few areas, steel has proved satisfactory where HCl is absent.

Chlorination. The favorable working temperature range for chlorination of benzene with the HCl—air mixture is only about 50°C. Equilibrium considerations preclude reactor temperatures exceeding 270°C, while satisfactory rates are possible only above 220°C. Being strongly exothermic, the reaction needs close and automatic temperature control. Hooker's Durez division has accomplished this by using a cell-type steel reactor, in which only alternate cells are filled with catalyst.[3] Thermocouple-actuated controls provide for cooling by external air flow.

Reactant ratios and contact times are so chosen to give a benzene conversion of 10-15 percent per pass, which converts all but 2 percent of the HCl. Under these conditions, the product typically contains about 6 percent of polychlorinated benzene. Longer contact time tends to increase byproduct formation.

Leaving the reactor the product vapors enter and are condensed in a ceramic-packed column using a benzene-water azeotrope reflux. A two-phase system leaves the bottom of this tower: (1) a benzene-chlorobenzene layer and (2) an aqueous HCl layer.

The organic product layer is decanted and neutralized with dilute caustic. The products are separated in two successive fractionations, the first of which takes off a benzene overhead for recycle. The bottoms feed to the finishing column where monochlorobenzene is taken off as overhead (98 percent) for use in the second hydrolysis step. Higher boiling products including dichlorobenzenes may then be further purified, or sold in crude form.

Hydrolysis. Chlorobenzene is hydrolyzed with steam at 450-500°C using a catalyst such as tricalcium phosphate or silica gel. Under these conditions, catalyst life is quite short, and standby units are needed to allow for frequent changing. The chlorobenzene-water feed, preheated by exchange with the reactor product vapors, is brought to temperature in a furnace before entering the reactor. For each cubic foot of catalyst volume, some 8 pounds of phenol are converted hourly, with conversions between 10-15 percent.

Recovery. Because of low conversions, process heat loads would be excessive were it not for an ingenious selective condensation of the product vapors. These vapors, cooled to 270°C by heat exchange, are introduced near the bottom of a packed tower, while water is added at the top. Chlorobenzene and phenol are taken overhead as azeotropes, and aqueous HCl is drawn off below for recycle.

Makeup chlorobenzene from the first stage joins this vapor stream for extraction with 90°C water in a packed tower. Phenol dissolved in water comes out the bottom of the tower, and over to the top of a second tower where the phenol is counter-currently extracted with benzene. Hot water recycles to the first extraction tower.

Phenol dissolved in benzene goes to a continuous column where the benzene vapor overhead is heated in a furnace to 225°C for recycle to the first chlorination stage. Finally, the phenol is purified in a finishing column, with a 2 percent residue of polyphenyl compounds ("phenol tar").

CUMENE PROCESS

In this petrochemical process, cumene is oxidized to cumene hydroperoxide (CHP), followed by decomposition of the latter to produce phenol and acetone (See Figure 5). The steps are basically as follows:

1. Catalyzed air oxidation of cumene to CHP in an alkaline emulsion.
2. Acid decomposition of the CHP to produce phenol and acetone in nearly equivalent amounts, plus small amounts of acetophenone and alpha methyl styrene.

Oxidation. Cumene is dispersed in an aqueous medium, kept alkaline (pH 8.5-10.5) usually by sodium carbonate, and emulsified with a compound such as sodium stearate. Catalysts and promoters are also often present in amounts from 0.2-0.5 percent of the total. Catalysts are usually selected from oil-soluble salts of heavy metals such as manganese, cobalt, or copper; promoters include a wide variety of compounds, among them formates, amines and terephthalic acid.

Air, free of carbon dioxide, is the usual oxidizing agent. However, oxygen enrichment is also practiced to

increase the rate of oxidization and decrease cumene carry-out. Agitation to promote phase contacting, is provided while the oxygen-carrier is bubbled through. Pressures are typically around 1 atmosphere, or slightly above.

The heat of reaction—some 300 Btu's per pound—is more than sufficient to maintain the temperature in the desired 160-200°F range. Cooling jackets on the reactor is needed to keep the maximum temperature within this limit, or else thermal decomposition of the CHP would result.

A small amount of CHP at the start helps initiate the reaction, but otherwise the cumene should be substantially free of impurities, especially phenol, sulfur compounds, and styrene. Conversion rates are between 7-8 percent per hour, and the degree of conversion taken is between 25-35 percent. Higher conversions can be realized but yields tend to drop more sharply. One operation seeks to avoid the yield penalty by going to successively lower temperatures as the conversion increases.

When the desired conversion level has been reached, the emulsion is removed from the reactor, and the CHP is concentrated by vacuum or steam distillation, which takes off most of the cumene overhead. This is purified and then recycled to the reactor.

Decomposition. The crude CHP, now concentrated to about 80 percent, is dissociated with acid, usually sulfuric. Several parameters, including acid concentration and temperature, determine the rate of reaction. Considerable heat is generated and adequate cooling must be provided to prevent thermal decomposition of the CHP and other side reactions. Preferred temperatures are usually between 120°-145°F.

Most decomposition practice has evolved around dilute (5-10 percent) acid, the use of which results in formation of two layers. Inasmuch as the products are soluble in both layers, however, subsequent separation by fractionation is no simple matter. To avoid this problem, several producers have investigated a homogeneous decomposition medium.

For example, Hercules Powder[4] describes a technique of dissolving sulfuric in acetone, substantially under anhydrous conditions. This technique has the further advantage that vaporization of acetone helps in controlling the reaction temperature. Another producer, Rhone-Poulenc[5] describes the use of phenol as a homogenizing medium. In either of these cases, the CHP can be added to the acid solution or the two fed in together, to give a rapid reaction. The concentration of CHP at a given time is kept low, usually under 1 percent.

Separation. Product separation techniques are largely guided by whether a single phase or two phases is present, after the decomposition is complete. In the single phase system, components can be readily separated by fractionation. In the two phase system, the separation can also be accomplished entirely by fractionation; but more often a combined method of fractionation and extraction is used.

- **One Phase**—The dissociation product is first neutralized, precipitating a small amount of sodium sulfate. The various products are fractionated as shown in Figure 5.

- **Two Phase**—The two layers are separated by decanting and fractionated separately. After separating acetone in the organic layer by fractionation, the bottoms are extracted with hot water (70-80°C) to extract the phenol and part of the acetophenone.[6] The organic

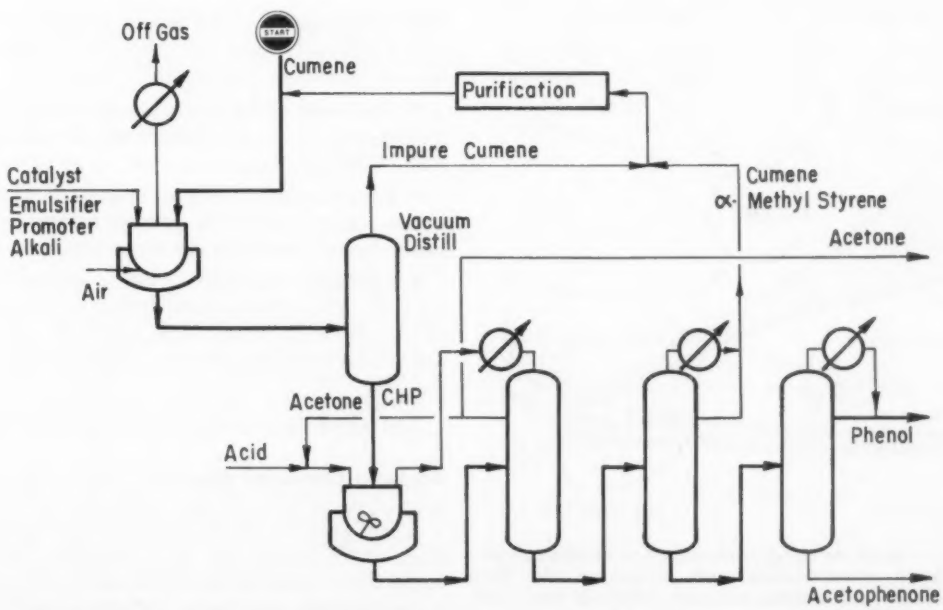


FIGURE 5—Truly petrochemical, phenol from cumene, follows this general arrangement.

raffinate is distilled to give cumene and alpha methyl styrene, which are recycled, after hydrogenation and purification.

Extraction of the water layer with a solvent like butyl acetate then removes about 99 percent of the phenol. To recover the phenol, the butyl acetate is topped off and then the phenol is fractionated in a finishing column. Acetophenone is recovered from the bottoms in this operation.

BYPRODUCTS AND CO-PRODUCTS

Ever-mindful of the process competition, each phenol producer is constantly striving to wring out more production and trim costs in his own operation. But making of meaningful economic comparisons is soon complicated by the key importance of byproduct and co-product values (See Figure 6). They represent only about 5 percent of the total value in the Chlorination and Raschig-type processes, but even this can be significant where competition is keen.

However, in the sulfonation and in the cumene processes, the secondary products take on considerably more importance. In sulfonation, the byproducts contribute some 20 percent of the total output value, and weigh more than half again as much. In the cumene process, the acetone co-product is about 35 percent of the total by weight and some 23 percent of its value.

Particularly in these latter two cases, producers face the necessity of profitable sale, or use of these auxiliary compounds. Large bulk and low value of the sulfonation byproducts—chiefly sodium sulfite and sulfate—calls for a willing buyer nearby, usually a pulp and paper mill. In the case of cumene acetone, the shipping radius is less critical; but the market, both present and future, has to be estimated in terms of total demand and competition from other sources of acetone.

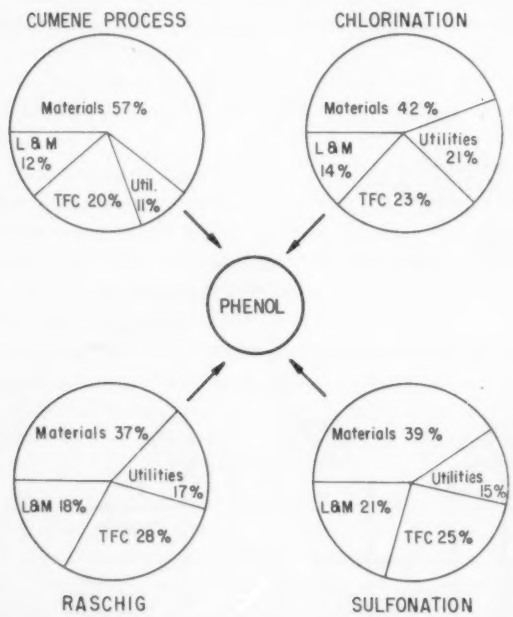


FIGURE 6—Based on equal production cost of 10 cents per pound, phenol manufacturing costs breakdown like this. L + M is labor and maintenance costs; TFC is taxes and fixed charges (Depreciation, insurance); Materials is net after byproduct credits.

ACETONE SITUATION

About 11 percent of the U.S. acetone production now comes from the cumene phenol process. The market impact of such a quantity is greater than might first appear because of the cumene-derived acetone growth, and because of periodic spottiness in acetone demand. As a result, the future of cumene phenol becomes closely linked to the overall acetone prospects.

Two main forces are shaping the acetone outlook:

1. Acetone supplies from the dominant sources—the processes based on isopropyl alcohol (IPA).
2. Growth rate of acetone demand in chemical products, especially methyl methacrylate and bisphenol A. The latter, a product of phenol and acetone, is keyed to the epoxies and polycarbonates.

Acetone Processes. The largest single source of acetone by far is the oxidation-dehydrogenation of isopropyl alcohol, which itself accounts for 75 percent of the total supply. Just before the advent of cumene acetone, this IPA process was turning out over 90 percent. A hefty boost from this source came with the recent completion of Enjay Chemical's new unit of 110 million pounds annual capacity.

The second IPA-derived acetone source is that which Shell Chemical is now using at Norco, La., to make glycerine, with acetone as a co-product. This new IPA source could supply some 8 percent of the U.S. acetone needs.

Other Sources. In addition to the IPA processes and cumene-phenol, there are also the following acetone sources, actual or potential:

- **Oxidation of LPG**—A yearly capacity of some 40 million pounds is available from the Celanese Corp. unit at Bishop, Tex.
- **Fermentation**—Once an important source, fermentation has continued to retreat before petrochemical methods, and now puts out some 4 percent of the total.
- **Synthetic Gasoline**—The inoperative Fischer-Tropsch unit at Brownsville, Texas, is a potential source of acetone. Each 10,000 barrels of daily gasoline output would also result in some 18 million pounds of acetone per year.

The trends in acetone processes are shown in Figure 7.

Acetone Chemical Markets. More than once in the past 10 years, the acetone market has felt the effects of a supply glut, chiefly the result of slowdown in acetone demand for solvent use. With increases in acetone capacity apt to come from several quarters simultaneously, oversupply can become a probability unless at least a corresponding growth of acetone uses can be realized.

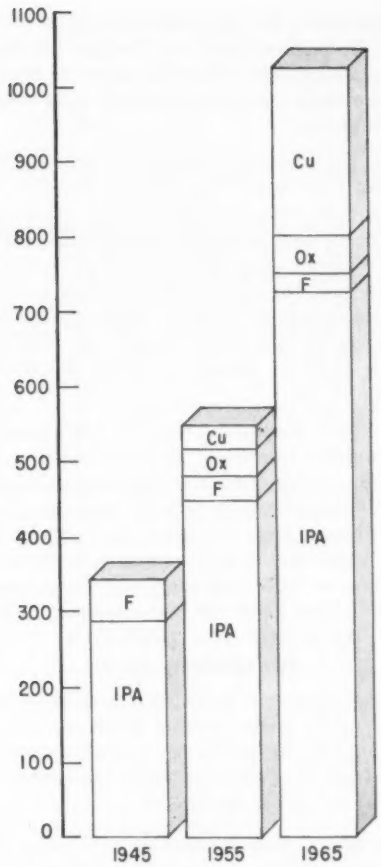


FIGURE 7—Here's how acetone process trends breakdown for 1945-1965. Cu—cumene; Ox—oxidation; F—fermentation; IPA—isopropyl alcohol.

Significant changes in the pattern of acetone demand are giving its producers grounds for encouragement. Acetone has been drawing away from its primary use as a direct solvent. More of it is used as the intermediate by which other solvents such as MIBK are made. But the most striking increases have come in the manufacture of chemical products, including methyl methacrylate and bisphenol A.

Buoyed up by the epoxies and polycarbonates, bisphenol volume is due to double in the next five years. Methyl methacrylate, which went through an extended and gradual development, now is climbing sharply. The change is mainly the result of increasing demand in four product categories: acrylic lacquers for autos and appliances; acrylic emulsions for interior and exterior coatings; copolymers with polyesters and with styrene; and sheet stock for panels, skylights and display signs.

These two chemical products are expected to provide the springboard for acetone growth and diversification. Among new use possibilities, polymers made from acetone have been reported under development; a new, non-chemical use with volume possibilities is in quick drying of lumber.

Figure 8 shows the trend to chemicals in the end use pattern. Thanks to such uses, the acetone demand trend appears strong enough to assist rather than hinder future cumene phenol expansion.

NEW OXIDATION ENTRIES

Not every company that wants to make phenol is equally sold on the idea of taking other products with it, favorable though their prospects may be. For this reason, even with four routes to choose from, some producers have kept looking for some new process which would give economically feasible yields and conversions, but little or no byproducts. Even if such processes were no better on the average than those now available, the fewer associated marketing problems might be a plus factor in deciding on a plant site.

Dow's two-stage toluene oxidation process is one such contender, though not the only one being readied for commercial operation. A second entrant, announced last year by Scientific Design features a direct oxidation of benzene. The process, according to S-D, is adaptable to small packaged plants and gives a minimum of byproducts.

Processes such as these may well foreshadow a trend which eventually could exert considerable impact on the future of phenol processing. This may be too early for accurate evaluation. More than likely, however, these will establish a niche of their own, thereby further augmenting the petrochemical role in phenol manufacture.

The achievement of a direct oxidation process would mean the fulfillment of a long-sought-hope of phenol producers. In the history of commercial phenol, many attempts have been made at direct benzene oxidation, only to be found lacking for some reason. One of the more recent and advanced of these ventures was Allied Chemical's pilot plant built during World War II, and dismantled less than a year later.

Until now at least, the chief drawback in such at-

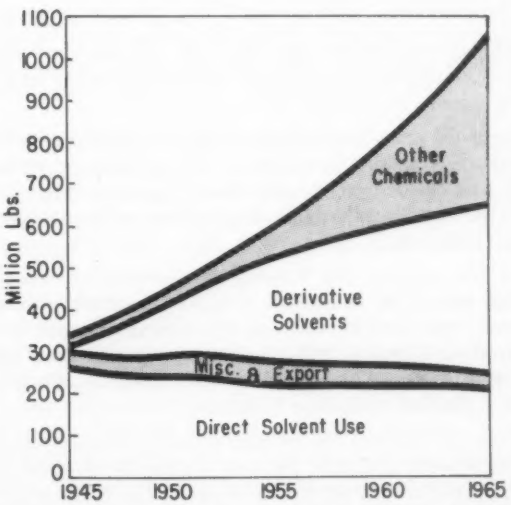


FIGURE 8—Other chemical manufacture and derivative solvents are the real factors in changing acetone end use trends through 1965.

tempts has been the low yields, low conversions, or both. Starting and controlling the reaction has proved difficult. Among the varied techniques to improve results have been the use of a wide range of catalysts, modified feed stocks, operating conditions and reactor design. None of the combinations tried has yet proved satisfactory for direct benzene oxidation. But moderate improvements in conversion or yield might well enable direct oxidation of benzene to advance into a competitive position.

Dow Chemical approaches the same goal indirectly with its two-stage oxidation of toluene. Selective oxidation of the methyl group to make benzoic acid, and oxidizing this intermediate to phenol over a copper catalyst. Though the two-stage process may appear more cumbersome, this could well be offset in Dow's process by lower raw material cost, higher yield, and minimal byproducts.

PROBLEMS AND DECISIONS

The byproduct question has been a perennial feature of commercial phenol production. Byproducts could serve as an incentive or a deterrent at different times, depending on company plans and locations. But in coming to a decision on which process to use, companies knew they would need markets lined up for the byproducts. The other alternative would be to come up with another process with more marketable or fewer byproducts.

For example, Dow's development of its chlorination process for phenol around 1924 was largely governed by three considerations which applied to its Midland, Mich., operations:

1. Abundance of chlorine and caustic from electrolytic operations

2. Accessible and growing markets for phenol

3. Market development which encompassed not only phenol, but its derivatives and the byproducts such as diphenyl ether.

The process became feasible with the discovery that recycle of diphenyl ether could be used to control its net production. (U.S. 1,806,798.)

Some 20 years later, General Electric wanted to build a relatively small phenol plant for its phenolic resins. G-E also decided on the chlorination process, but being little interested in the byproducts, chose to operate with maximum recycle.

In like manner, the Raschig process resulted from a search started by F. Raschig G.m.b.H. in 1928 to make phenol with few byproducts. First used commercially at Ludwigshafen in 1935, the process was licensed and put into U.S. operation around 1940 by Durez Plastics, later a division of Hooker Chemical.

With the entry of the cumene phenol process, a fourth route became available, yielding a valuable co-product. But the full economic attractiveness of the cumene process package hinges on acetone's profitable use or sale. To no one's surprise, those who chose to use the process have for the most part been petrochemical companies whose plans called for using the majority of the acetone, as well as the phenol, produced. Others who had to depend on open-market selling for most of their output would more than once have felt the sting of demand-price fluctuations.

Benzene, the chief raw material in all these processes, has also presented recurring problems. Between 1950 and 1952, the supply problem became really acute when Korean war needs were added to demands for phenol, styrene and synthetic detergents, all of them booming at once. Since then, the growth of petroleum benzene from catalytic reforming and lately from dealkylation has solved the supply problem, though the 50% cost increase since 1950 has tended to whittle down profitability in phenol.

Maturing and fluctuating demand for phenolic resins has been another worrisome and growing problem. Aggressive competition from the thermoplastics especially has been holding phenolics to a relatively small share of the plastics boom. Phenolics have also been highly sensitive to the trends in the U.S. economy, as these statistics indicate: Sales in 1959 were about 15 percent better than in 1958, and about 5 percent better than in 1960.

BRANCHING OUT

Aware of the risks in continuing such heavy dependence on its major outlet, phenol producers and important users alike began to lay the groundwork for broadening the base of demand. Their diversification has proceeded along two main lines:

1. To promote phenolic uses in laminating, bonding and coatings as well as new uses for molded phenolics.

2. To develop and promote additional uses for phenol, other than in phenolics.

In the first of these goals they have met with moderate success; growth of phenolics in laminates and bonding has more than doubled that of molded phenolics in the past five years. Two of the main reasons: moisture-resistant plywood laminate exteriors, and phenolic-bonded panels. Protective coatings based on phenolics and modified phenolics have also been making consistent progress in the same period.

Most of the progress, however, has been made toward the second of these goals. Almost every producer expects to share in at least one of four burgeoning non-phenolic uses which have gained increasing prominence since 1955. Three of this group are plastics: expoxies, caprolactam, and polycarbonates; the fourth—alkylphenols—go primarily for the booming nonionic surfactants.

• **Epoxies** were developed in the mid-1940s by Ciba in Switzerland and by Devoe and Raynolds in the U.S. The former's interest was primarily in stronger adhesives, while the latter was after superior protective coatings. Both found the answer in epoxies made from bisphenol A and epichlorhydrin. Soon afterward, Shell Chemical—supplier of the epichlorhydrin—came in vigorously and has since become the volume leader in epoxies.

• **Caprolactam** (Nylon 6) is a self-condensing polymer of the nylon family, first commercialized in Europe. In 1954, it was introduced to this country by Allied Chemical, which to date has been the sole U.S. producer of the monomer. However, both DuPont and Dow are also slated to become caprolactam producers this year, though neither is now planning to use phenol.

• **Polycarbonates** are a group of extremely tough thermoplastics discovered independently by General Electric in the United States and by Farbenfabriken-Bayer in Germany. Ever since, it's been one new development after another as each company tries to get the upper hand. Both companies went into U.S. production last year: General Electric at Mt. Vernon, Ind.; and Mobay Chemical, Bayer's joint venture with Monsanto, at New Martinsville, W.Va.

• **Alkylphenols,** currently the third largest phenol user, are produced by alkylation of phenol with olefins. Upon reaction with ethylene oxide, adducts are produced which are used to make nonionics, the fastest growing segment in detergents.

OUTLOOK FOR GROWTH

The brightness of such prospects could be misleading unless due regard is given to the impact of alternate products or processes. This type of rivalry will probably be felt most strongly in caprolactam and to a lesser extent in epoxies. But even after these effects are taken into account, phenol prospects taken as a whole are the most favorable in many years.

• **Epoxies.** These thermosetting resins embody an outstanding combination and range of properties. Particularly outstanding are: their adhesion, their resistance to the effects of chemicals and weather, and their toughness combined with controlled flexibility.

Excellent dielectric properties help epoxies find many electrical and electronic uses in encapsulation, printed circuits, and insulating varnish. Dimensional stability, toughness and low shrinkage helps explain their leading part in plastics tooling.

Surface coating uses are still the most important, though they now take 35-40 percent of the epoxy total, compared to about two-thirds five years ago. But soon, epoxy growth in other uses is expected to gain more sharply. Major new areas are opening up, aided in part by improvements in formulation and in application techniques. Such improvements include development of spray gun method; one-shot epoxy systems; and a wider selection of curing agents, diluents, and hardeners which are more convenient, faster setting, or lead to enhanced properties.

Significant breakthroughs are expected in the next two years, with highway and building construction shaping up as the new area of great volume potential. Some of these construction uses include:

• **Highways**—Traffic buttons and marker adhesives; concrete bonding, maintenance, and repair; anti-skid surface treatments.

• **Buildings**—Building aggregate based on epoxy-sand combinations; structural adhesives; sealants; weatherproofing of concrete or cinder blocks; heavy-duty floor finishes; honeycomb-bonded structures.

Important industrial applications are due in metal-bonding of assemblies, plastics tooling, equipment and piping. Uses in surface coatings and premium quality reinforced plastics should start growing at a faster pace despite overlapping competition from lower cost products.

The past for epoxies has been beset by cost barriers as well as by difficulties of application. Application problems by now have largely been solved. Costwise, epoxies should benefit from imminent volume increases, and also from modification of epoxies with lower cost materials. Some of the modifiers include fillers, diluents and copolymers; among them are asphalt, flame-retardants, metal fibers, and a number of lower cost polymers.

Still other approaches in epoxies have resulted in entirely new types such as epoxidized olefins and terpenes. Several companies, notably Union Carbide and Food Machinery have been active in these areas. These products, on the average, requires less bisphenol, and some are lower in cost. Properties are generally similar but by no means identical with those of more conventional types, and curing behavior differs considerably.

Development of new epoxies less dependent on bisphenol is one that will bear watching. By 1965 such types will probably comprise 15 percent of the total. But in view of the overall epoxy demand expected in this period, the growth of bisphenol-epichlorhydrin products should not be substantially hindered by the olefinic types. Demand should almost double between 1961 and 1965.

Caprolactam. The avid and widespread interest in this particular type of nylon can be traced to ease of processing and property characteristics. Several advantages are claimed over nylon 66, its predecessor:

• **Molding**—Caprolactam is more easily processed because of its lower melting point and its higher melt viscosity. Better control both in polymerization and also in the molding process results in greater uniformity in large and heavy sections.

• **Fibers**—Caprolactam fibers are said to be superior in dye acceptance and in fabric characteristics. For tire cord, its resilience, impact strength, and adhesion to rubber should prove helpful in contending with nylon 66, rayon and other fibers for this lucrative 300 million-pounds-per-year market.

For phenol producers, bullishness about caprolactam will be tempered by the fact that caprolactam can also be made by other means. DuPont will start with cyclohexanol at Beaumont, Texas; Dow Chemical's process is one developed by its U.S. affiliate, Badische-Anilin, from cyclohexylamine and hydrogen peroxide.

Even Allied Chemical, securely committed to phenol, is said to be receiving technical assistance in its current caprolactam expansion from Snia Viscosa, an Italian firm which has developed a caprolactam process via toluene. Yet Dutch State Mines, a European Dow affil-

iate going into caprolactam, will probably make it from phenol.

These and similar expansion plans for caprolactam, the second largest phenol user, are closely watched by phenol producers. The present outlook is that other process routes through cyclohexanol will become established and give phenol some rugged competition for future business. But due to its early entrenchment and more familiar technology, the route through phenol should still be meeting most of the caprolactam demands in 1965. And because of the robust caprolactam demand, phenol requirements will show some 25-30 percent increase in this period, despite cyclohexanol process inroads.

Polycarbonates. This heralded and highly regarded thermoplastic newcomer is produced from bisphenol A and phosgene. The hectic pace of activity in its behalf by the two producers—G.E. and Mobay—clearly shows their abundant confidence in its future. Both have been carrying on intensive programs of product development and application research. In the past three years, more than 75 types of polycarbonate modifications have been developed and well over 500 applications have been successfully made.

The first two polycarbonate units were completed last year, giving the two producers a combined capacity of around 10 million pounds. This output will most likely be stepped up in the next six months, probably by the current producers, and very possibly by others who have been looking for the opportunity to participate.

Union Carbide for example has been preparing and evaluating resins of this kind. Columbia-Southern Division of Pittsburgh Plate Glass has been pilot planting a 1,000-pound-per-day unit at Barberton, Ohio, for like reasons. This twosome may also be in hopes either that the patent situation will be clarified, or that their own can be bolstered. The already strong patent positions of G.E. and Bayer has been further reinforced by cross-licensing, though on a non-exclusive basis. However, in the past year, several Japanese firms have laid claim to new discoveries, and have gone into polycarbonate production of a limited scale.

Of the polycarbonate virtues which help explain their popularity, probably the chief one is its impact resistance, but close behind would be its resistance to temperature and to creep. These properties give it the desirable characteristics of a true engineering material.

It's no secret that a major objective in polycarbonate marketing strategy is to oust metals from a multitude of fabricated parts such as are used in appliances, office machines, and photographic equipment. Automobiles are also expected to furnish many opportunities. According to their plans, producers figure that many copper alloys, zinc castings and others could be replaced with improvement in cost, performance or both.

Similar hopes are also harbored for some nylon resins, but the greatest competition will probably be felt from the polyacetal resins. Introduced about the same time as the polycarbonates, polyacetal resin applications have been increasing at comparable speed. Comparison of properties shows many resemblances, though polyacetals lacks the outstanding impact resistance of the polycarbonates.

Price competition has already become conspicuous, as the producers go out boldly for big volume. To encourage polycarbonate growth, G.E. and Mobay slashed prices from $2.50 to $1.30 per pound. With polyacetals, DuPont has made a series of reductions, the latest on March 7 from 80 cents to 65 cents per pound. When large volume use for both has been reached polyacetals will probably be about 25 percent lower in cost. Demand for polycarbonates should reach about 40 million lbs. by 1965.

Alkylphenols. These alkylated products from phenol probably constitute its third largest use at the present time. Though octyl and nonyl are probably the most widely used, many different lengths from C_4 to C_{18} are available. First commercial development was in lube oil additives and in oil-compatible resins, but alkylphenols' greatest growth and prospects have coincided most closely with the rise of nonionic surfactants.

Nonionics, the fastest growing segment in surfactants, now holds about 25 percent of the market. Three important advantages they offer are: greater stability, compatibility, and synergistic action. By suitable choice of olefin, and by the proportions of ethylene oxide in the adduct, an unusually wide range of properties vs. cost becomes available. Alkylphenols can also be used in making high-foaming anionics.

Apart from surfactants, alkylphenol prospects appear favorable in many other uses including rubber chemicals, antioxidants, lube oil additives and specialized drilling muds. Some 70 million pounds of phenol were required for all alkylphenol purposes last year. By 1965, alkylphenols could become the second largest phenol user.

Phenolic Resins. Despite a gradual slowing down in their growth rate, phenolics for some years to come will continue to be the major single phenol outlet. They should require some 425 million pounds in 1965. But hard-pressed by the rise of other plastic materials, phenolic resin producers are bearing down to find new uses and diversify. To their advantage is the fact that these resins are so well-known for superior all-around properties at moderate and stable prices. Moreover, they are available in hundreds of different formulations and used in thousands of applications.

More development and promotion will, however, be needed if the expected slowdown in phenolic molded materials is to be countered. Ten years ago, molded phenolics were taking more than 50 percent of the phenolic resins; by 1965 this will probably be below 30 percent.

By comparison, surface uses of phenolics such as in laminates, plywood bonding and in coatings have been increasing. Altogether, their share now is more than half the phenolic resin output, and by 1965 this should come to 60 percent. Thermal insulation, brake linings, and abrasives are three uses which show only slight annual increases. Phenolic shell molding for foundries has not yet lived up to early expectations, but should fare better as competition pressures improved foundry practices.

Newer product varieties include foamed phenolics and

tiny hollow spheres; phenolics coated with light-colored epoxies; and a growing list of modified phenolics for greater flexibility and high temperature resistance. Performance gains and cost reductions have been realized from improved fillers, and from more automatic molding cycles.

The scope of these activities adds up to aggressive diversification which has just started to pay dividends in volume. But in view of the more rapid growth of later phenol arrivals, phenolic resins will be taking a slowly diminishing share. This continued trend has reduced the phenolic resin share from 65 percent in 1950 to about 50 percent now, and about 45 percent in 1965.

Other Uses. Phenol's role as a chemical building block gives rise to a host of chemical products and intermediates, some of which are leaders in their own fields. Among them are such important and well-known uses as weed-killing herbicides including 2,4D compounds, and fungicides including pentachlorphenol; medicinals including aspirin and other salicylates; plasticizers such as phenyl phosphates; and many others.

• **Weed-killers**—Of the selective herbicides based on phenol, compounds of 2,4D are still the most important despite the rise of more recent developments such as 2,4,5 T products. Some nitrophenols also find application in related uses. The combined output of all three types last year came to about 100 million pounds, requiring about 40 million pounds of phenol.

• **Fungicides**—Dominant in this group is pentachlorphenol for which demand has been rising at a steady pace. Production in 1960 was some 110 million pounds which took another 40 million pounds of phenol. Pentachlor is used chiefly in wood treatment to resist fungus and termites. The treatment is more expensive than creosoting but offers the dual advantages of being more effective and not requiring pressurization.

No small measure of penta's growth has been due to its active promotion by Dow, Monsanto, and Reichhold. Penta and its sodium salt are used for control of slime and algae, and new markets for either are currently being sought in fabrics and paper.

• **Miscellany**—To attempt a complete listing of other phenol-derived products would be well outside the scope of this article. However, a few examples of other uses will typify its versatility: dyes, germicides, photographic chemicals, anti-oxidants, explosives, and medicinals. The last of these is probably the most important, including aspirin and other derivatives of salicylic acid.

Refiners are well acquainted with phenol's use as a selective solvent in lube oil refining to extract aromatics for improvement of viscosity index and oxidation stability. Phenol extraction is used in some 25 refineries, domestic and foreign, processing some 30,000 barrels daily. This use has shown no significant increase in recent years. Other direct and steady uses of phenol include textile and leather treatment, plating, and disinfectants.

Phenol end use trends are shown in Table 2.

TABLE 2—Phenol End Use Trends 1945-1965

Use	1945	1950	1955	1960	1965
Phenolic Resins	140	195	285	358	420
Chemicals					
Other Plastics*	...	8	41	136	248
Herbicides & Fungicides	4	27	54	82	116
Alkyl Phenols	3	9	32	67	120
Other					
Medicinals	10	13	17	21	25
Industrial Uses (Incl. Pet. Refining)	8	12	14	15	16
Misc. & Export	32	28	35	33	27
Total (Million Lbs.)	197	292	478	712	972

* Includes Epoxides, Caprolactam, Polycarbonates and Plasticizers.

OTHER FACTORS

The foregoing discussion has presented in brief most of the main aspects relating to phenol's status and its prospects for the next four to five years. To help round out this picture, a few other pertinent factors and trends should be duly considered:

Captive Users. A steadily growing share of phenol output is being used by the company which makes it. Fifteen years ago captive use was about 15 percent of the total. Today it is around 50 percent and still tending upward (Figure 9). Two reasons will explain this trend: 1) Upgrading to more profitable products 2) Diversification to smooth out demand fluctuations. One of the major producers—Monsanto—now converts some 75 percent of its phenol output, and chances are some of the others are close to the same bracket.

Foreign Trade. Though foreign production has been climbing fast in the past few years, phenol exports have been holding up well, averaging some 30 million pounds annually. This will probably diminish gradually, and level off in 1965 to some 15-20 million pounds. Imports have been negligible and are not likely to become a factor under present tariffs.

Other Sources. Practically all the phenol to be made in the next 5-10 years will come from the routes described earlier. But the effect of other sources should be noted:

1. Some 25-35 million pounds per year is derived from coke oven output. Coal hydrogenation may event-

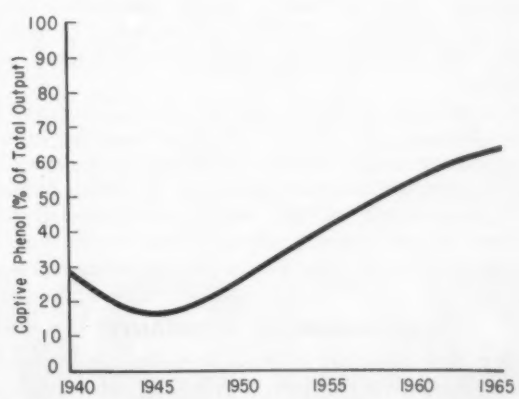


FIGURE 9—Captive use of phenol shows a steadily increasing percentage of total output.

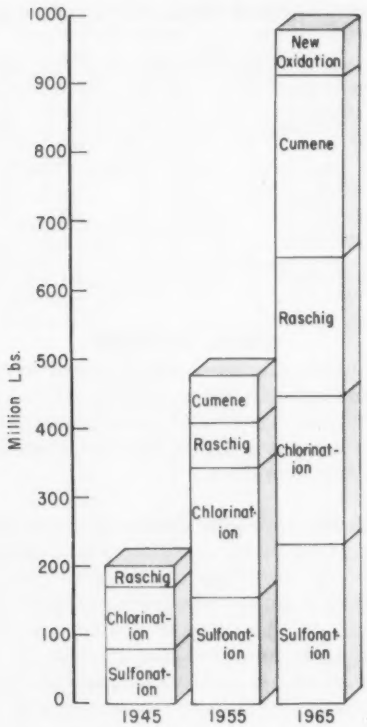


FIGURE 10—By 1965 Cumene phenol will be the largest single process even with the newer processes coming into the field.

ually become a large potential source, but this would probably be at least 10 years hence.

2. Cyclohexane could become a contributor to phenol supply as well being in competition with it for caprolactam manufacture.

3. New techniques such as radiation or plasma arc may also reach the stage of being competitive, but these now are for the most part in the "blue-sky" stage.

Materials and Process Trends. The economic balance in phenol will necessarily reflect future changes in materials cost and availability. Some trends to keep in mind are: Costs of chlorine, caustic and sulfuric acid; cost and availability of HCl; incremental propylene costs; and relative cost and availability of benzene and toluene.

Continuation of past trends will operate in favor of petrochemical and Raschig processes over the others, especially since they are more recent and are most apt to benefit from technical improvements. By 1965, the leading processes will be fairly well bunched according to output, but the cumene process should be the leading source of phenol. (See Figure 10 for phenol process trends.)

PETROCHEMICAL ASSURANCE

It is now becoming increasingly evident that phenol, far from reaching maturity, is going through a phase of expansion and far-reaching changes, aimed at fuller exploiting its versatility in chemical products. The effects of changing technology will be to favor further growth of cumene process phenol, particularly since the acetone demand has also firmed up from chemical demand. Still newer processes and techniques are beginning to emerge into volume production. In the midst of all this change, the surest prediction is that petrochemicals will be the biggest gainer.

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Key Words for Indexing

Acetone
Byproducts
Capacity
Caprolactam
Capacity
Catalysts
Centrifuging
Chlorination
Chlorine
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Distillation
Economics
Epoxy plastics
Equipment
Evaporators
Fungicides
Fuzing
Herbicides
Hydrogen Chloride
Kettles
Iron Chloride
Isopropanol
Isopropyl benzene
Nylon
Oleum
Oxidation
Phenol
Processes
Producers
Polycarbonates
Pots
Reactors
Sodium sulfite
Sodium sulfate
Sulfonation
Sulfur dioxide
Sulfuric Acid

(See "New Information Retrieval Standards," Petroleum Refiner, Vol. 40, No. 5, May 1961, p263.)

About the Author

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Gordon

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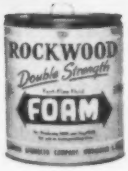

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HOW MUCH OF YOUR KNOWLEDGE IS YOURS?

As technology gets more complex, it's more important that engineers understand the law of proprietary rights. Here's your chance to see how the courts dealt with some cases in point

Lawrence A. Coleman, General Counsel, Allied Chemical Corp., and **Charles B. Cole,** Member, California Bar

To the truck driver who learns to drive while working for Company X—then quits to take a job driving trucks for Company Y, it is clear he may take with him the truck-driving skills. Of course he may! On the other hand, it is just as clear to him that he may not take along Company X's truck.

Judging from several recent lawsuits, these basic legal principles are not as easily understood by some highly educated engineers and chemists as by our truck driver.

Non-Statutory Laws. Maybe the general emphasis on patents has led to overlooking non-statutory laws protecting trade secrets from exploitation by those who don't own them. The granting of a patent is somewhat akin to registering the title to a truck, i. e., the subject matter of the property is carefully described, distinguished from similar other property, and title is recorded.

Laws for motor vehicle registration set out the way to easily find title to a truck. Likewise, patent laws give limited protection to the inventor's idea. But there also is a wide legal field covering the protection of trade secrets at common law, in equity, and by contract. California, for example, has fixed such protection by statute. This statute, generally, gives one the right to keep to himself his ideas and results of his own work or work he has paid for. This holds true even if the work is not patented or patentable.

Others are at liberty to do similar work and freely use the fruits of their labor. However, they may not take the easy way by stealing the ideas or results of others' work.

The ideas and results of work need not meet the statutory definition of patentable subject matter. The general criteria for a trade secret are the time, trouble, and labor involved in development—not whether it amounts to an invention. The idea need not be new—merely one not generally known in the field so that there is a commercial advantage in preventing its disclosure.[2]

Legal Recourse. The unauthorized disclosure of such ideas and results of work may be prevented by injunction. The unlawful recipients of information may be restrained from making use of it.[3] However, no relief will result for the complaining party if there has been a prior disclosure to the public without reservation.[4] This is also true if the idea was otherwise well known when applied to the item in question.[5]

That there will always be untrustworthy employes goes without saying. Industry's experience in this field demonstrates, happily, that such are few and far between. But protection of industrial secrets must be sought against the unprincipled few, however few they may be. Perhaps unprincipled is too strong a word. The average technical employe is devoid of legal knowledge. Stealing a truck is clearly to him a crime. Stealing an idea—a concept—a scheme of adding bits and pieces to make a successful whole, is not so clearly a crime.

It is therefore a duty, not legal, but moral and practical, for each employer to advise his employes of the legal interpretations and result of any act amounting to trade secret appropriation. An employer can minimize the risk of trade secret loss by limiting the number of persons to whom the secret is made available. He can also bring the problem's seriousness to the attention of each employe by placing each under contract not to disclose secrets revealed to him.

CASES IN POINT

In three recent cases involving trade secrets, each firm holding the secret had protected itself by contract. They had also maintained proper security. But they failed to supplement this by educating employes, indicating a need for this additional help.

In *Monsanto Chemical Co. vs. Miller*[6] the defendent Miller, who had been employed by Monsanto for about ten years working closely with electric furnaces for making elemental phosphorous, left Monsanto. Two years later he became a consultant to—then an employe of—Central Farmers Fertilizers Co. That company was planning construction of electric furnaces to make elemental phosphorous.

Monsanto, over a period of 20 years, had designed, built and operated such furnaces. Its experimentation and development had involved large amounts of money. From the beginning, Monsanto had refused to

Outright theft of trade secrets can subject you to both criminal and civil prosecution.

release to the public its designs, cost data or other information. When its designs or cost experience became known to anyone else, it was because of unauthorized disclosure, certain supervised plant inspections, or through information given equipment suppliers.

Contractural Obligation. Miller and all other salaried employes were obligated by contract to keep confidential all matters concerning the process. Judge Christenson of the U.S. District Court of Utah found that such a contract was reasonable and not an unlawful restraint on the rights of employment freedom. In addition, he held that the nature of Miller's employment held him to a duty not to reveal engineering data, design, studies, or operating data given him by Monsanto.

Miller was enjoined from further disclosing or using the trade secrets involved. He had to return drawings, cost data, operation manual and other material taken from Monsanto. Monsanto was given the right to apply for an injunction against Torkelson, the enginering firm which had made blueprints and drawings of the proposed furnace for Central Farmers. This was in the event it should attempt further use or disclosure of information obtained from Miller.

The Court found that Torkelson knew or should have known that Miller was not at liberty to reveal confidential information received by him as a Monsanto employe. A separate action against Central Farmers Fertilizer Co. is still pending, and damages (money payment) against Miller and Torkelson have not yet been fixed in the decided case.

The Dixon Case. On April 24, 1958, Allied Chemical Corp. filed a complaint in the U.S. District Court for New Jersey against Dixon Chemical and Research, Inc., Dixon Chemical Industries, Inc., and four former employes of Allied.[7] The complaint alleged that Mr. Dixon, president of the two corporations, and one of the four former Allied employes named as individual defendants, recruited the other three employes. Each of these had a contractural obligation not to disclose special knowledge and experience gained in Allied's hydrofluoric acid or alum plants. It was alleged that these three employes were induced to disclose Allied's information to assist the Dixon company in designing and building a hydrofluoric acid plant and an alum plant.[8]

Allied suspected the disclosures of trade secrets had been made because of public announcements by one of the corporate defendants to its stockholders. Also, the latter had acquired design engineers with a wealth of background in these fields, and planned to go into the hydrofluoric acid and alum business.

Allied also believed that Dixon intended to use identical processes. This was because certain suppliers advised Allied they had been asked to bid on special equipment previously made by them only for Allied's plants. In addition, other employes of Allied to whom processes had been disclosed were being solicited by Dixon companies. Rumors were that the corporate defendants were capable of manufacturing hydrofluoric acid and alum because they had acquired Allied's know-how through Allied's former employes.

Before trial, Dixon Chemical and Research was required to produce its plans and blueprints for the proposed new plant. Allied's engineers recognized not only Allied's processes but design features used in its own plants. In addition, some drawings appeared to be Chinese copies of Allied's drawings. Unless the drawings produced were copies of Allied's drawings, certain similarities were unexplainable. Some striking similarities between the Allied plant and the one planned by Dixon made denial of copying an impossibility.

Pretrial depositions of Allied's three former employes who had technical training resulted in their taking the 5th Amendment to all questions other than "What is your name?". In his pretrial interrogation Mr. Dixon stated under oath that at the time the other three former employe defendants had been employed by him he had no plans to build a hydrofluoric acid plant nor an alum plant. He added he had not been in direct charge of their work and had no knowledge other than that they were designing the plants with information freely available.

The action was concluded before trial by two decrees mutually acceptable to all parties. In one, the Dixon

companies were permanently enjoined from using any drawings, sketches, models, engineering plans, specifications, economic studies, manufacturing cost estimates, capital cost estimates, operating manuals, and any and all other papers relating to hydrofluoric acid or alum. They were also enjoined for ten years from using the three former employes of Allied in any connection with hydrofluoric acid, alum or sludge-acid sulfuric acid.[9]

Allied also received a sum of money in damages. In the second decree, the three former employes of Allied were enjoined from the same fields for the same ten-year period while employed by Dixon. They were also enjoined, if employed elsewhere, from working in specified fields for two years and from aiding in design or construction of such plants for three years.

Employer's Self-Obligation. This case may not be technically a trade secrets case in the classical sense, because the only logical explanation of its facts and the pretrial immunity claim of three of the individual defendants is on the ground of actual theft of drawings. But it does point up the burden placed on an employer to say to his employes, "This is mine, and if you make it physically or in your head you do so at your own peril."

On October 20, 1958, the Chemetron Corporation filed a complaint against Catalysts & Chemicals, Inc., charging that its chief officer and others, all former employes of Chemetron, had offered to European manufacturers trade secrets, confidential information, processes and know-how of Chemetron with respect to certain catalysts. Chemetron has produced specialty catalysts since 1942. The former employes left National Cylinder Gas Co., Chemetron's parent company, in 1957. The action has not yet come to trial.

FOUR THINGS YOU SHOULD KNOW

I. What is a protectable trade secret and how do you keep it? In the Monsanto case, Judge Christenson stated that "A trade secret may consist of any formula, pattern, device, or compilation of information used in one's business and which gives him an opportunity to obtain an advantage over competitors who do not know or use it."[10]

Monsanto, unlike TVA which also produced elemental phosphorus from electric furnaces, made no authorized mention of its improvements or developments, or supervised plant visits. It obligated to secrecy those employes to whom it disclosed corporate knowledge. In Allied's case it had even prepared written scripts for each employe who conducted visitors through its plants. These scripts included a mapped tour so the visitor would not see any sensitive part of the plant. Visitor lists were screened to prevent access to the plant by too interested outsiders, and visitors were generally limited to family and school groups.

Drawings and blueprints, particularly those sent to suppliers as part of specifications, were protected by a legend requiring the recipient to keep confidential and to return when no longer needed.[11]

The Allied, Monsanto, and Chemetron cases each involved instances of regular employes who had access to confidential information as part of their work. The employes had enough service to know that the process had been the result of their employer's lengthy and expensive experimentation.

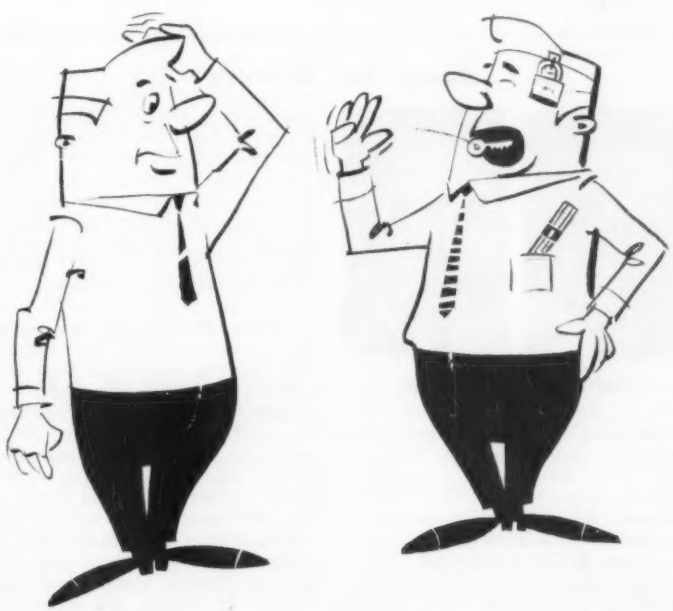
In the Allied case, one full-scale hydrofluoric acid plant had been built and never used. It was later torn down after the secret process known to the defendent's former employes had been perfected and operated at an adjacent location. Monsanto had spent years of engineering and experimentation on its furnaces. The familiarity that Monsanto's employes had with its costly efforts to develop a better furnace apparently prompted Judge Christenson to reject Miller's defense that Monsanto had failed to particularize its trade secrets, so that Miller was not bound to keep them confidential.

All this is not to say that every process and all equipment of an employer is per se entitled to the court's protection. An employer cannot, simply by *treating* well-known processes as secret, endow them with secrecy.

Even if an employer guards his process as though it contained the gold of Fort Knox, he cannot protect it against a former employe who, when employed by another, finds it in the literature and uses it to benefit his new employer.

But it must equally be remembered that an employe who purloins a secret formula, a drawing, a sketch, or any other physical thing—then uses it to the hurt of the owner—has breached the law. And, it is no defense that others know the secret.

But an employer need not spell out in detail just what is secret and what is not. The employer-employe relationship is one of confidence and trust. An attempt by an employer to deny to the employe terminating his employment the use of the fruits of his



To preserve your ethics you sometimes have to lock up your know-how and throw away the key.

own experience will not be condoned So, too, an employe may not claim he did not know that, say step "six" of a flow diagram was secret, although aware that steps "five" and "seven" were.

II. On what basis is a trade secret protected? One view is that a trade secret is a property right and protected as such. This viewpoint was recently restated by the Court of Appeals for the Fourth Circuit as follows:

> "In Herold vs. Herold China & Pottery Co., *supra* (257 F. 913), Judge Knappen, speaking for the Court of Appeals of the Sixth Circuit, stated the rule as follows: "The rule is well settled that secret formulas and processes, such as are claimed to be involved here, are property rights which will be protected by an injunction, not only as against those who attempt to disclose or use them in violation of confidential relations or contracts express or implied, but as against those who are participating in such attempt with knowledge of such confidential relations or contracts, though they might in time have reached the same results by their own independent experiments or efforts."[12]

More commonly, trade secrets are protected by the courts on the theory of unjust enrichment and the principle that equity will not permit the breach of an implied or contractural obligation of confidence.

This view approaches the loss for what it is—the loss of a secret. A secret once lost is lost forever. It is a property right that cannot be restored. The benefits of its disclosure can be taken from the recipient by injunction against its use. The eager discloser can be silenced by a restraining order and contempt penalties. It matters not that others have lawfully learned the secret—the one obligated to keep the secret may not violate the confidence.[13]

III. When is a trade secret no longer a trade secret? An authorized written disclosure will terminate a trade secret.[14] So also will a public exhibition without reservation.[15] Similarly, a public disclosure by another who lawfully discovered the same secret will end the secret. However, this does not necessarily end the obligation of maintaining the confidence. The secret does not have to be commonly known. It is lost if it is known by those engaged in the activity to which it relates.[16]

Often, the secret's elements are known in an entirely different field but the secret lies in combination of the parts. It involves the context of the use or application. The bits and pieces comprising the secret may be published separately. Again, such publication of the unassembled parts does not negate the secret. A piece-by-piece analysis of the secret with published references to each piece is a defense unsuccessfully attempted by many.

IV. Precautionary checklist. What methods will help prevent knowledge of trade secrets from becoming public?

1. Fence and guard the plant.

2. Do not admit unauthorized persons to the plant.

3. Legal Department review before release of articles and speeches made by professional and technical employes.

4. Limit the distribution of any blueprints, data sheets, photographs, and drawings, and provide clear legends therein as to confidential nature.

5. Contracturally obligate employes to whom disclosures are made to keep the same confidential until an authorized disclosure is made.

6. Investigate suggestions and new ideas offered by recently acquired employes to prevent unsolicited disclosures of the trade secrets of their former employer.

7. Make the common law of trade secrets familiar to all employes.

This article was condensed from "The Effect of Shifting Employment on Trade Secrets," which appeared in the January 1959 issue of *The Business Lawyer* magazine.

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[4] Skoog v. McCray Refrigerator Co., 211 F. 2d 254 (7th Cir. 1954).
[5] Note (4), *supra.*
[6] 118 U. S. P. Q. 74 (D. Utah 1958).
[7] Civil Docket No. 467-58.
[8] Allegation that Dixon induced other defendants to disclose Allied's trade secrets to benefit of corporate defendants was neither admitted nor demonstrated in depositions.
[9] Pretrial investigation indicated that secret data on Allied's sulfuric-acid process had come into hands of one individual defendant by means unknown to Allied. Because corporate defendants had also announced plans to build sulfuric-acid plant using sludge-acid decomposition process, Allied was prepared to amend complaint to include this field had not defendants agreed to its inclusion in decrees.
[10] *Supra,* p. 77.
[11] Such procedures are usual where competitive advantage often lies in cost differentials of a few cents per ton of product.
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[14] *Nims, Unfair Competition,* p. 402.
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Laws
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Coleman

Cole

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Charles B. Cole is a member of the California State Bar Association and the New York State Bar Association. He is manager of Allied Chemical Corp.'s Harmon Colors Division, Haledon, N. J., where he is in charge of manufacturing, sales, and research of organic pigments. He has been an attorney for 11 years, having passed the California Bar Examination in 1949. Mr. Cole has a B.S. degree in chemical engineering from Lehigh University and an LL.B. degree from Stanford University.

TOUGH MANAGEMENT GETS RESULTS

Toughness need not depict you as hardheaded, aggressive or belligerent. On the contrary—used with discretion, it can be a constructive element in your dealings with others

Auren W. Uris, The Research Institute of America

Many Companies want their supervisors to be tough, but aren't sure how it can be achieved. The problem is compounded by doubt as to what toughness really is. Some confuse it with unreasonableness, aggressiveness or sheer oral noise.

Toughness need be none of these undesirable things. On the contrary, it can be a constructive element in your dealings with employes, suppliers, unions, and others. Constructive toughness enhances your corporate image—makes it seem more solid, more forthright, more knowing.

And firmness, as a policy and practice for the supervisor, is an asset. The leader who knows how and when to get tough is more likely to have stable, satisfied and productive subordinates than one who doesn't. The company whose managers are firm is more likely to meet the challenge of better performance.

WHAT IS TOUGHNESS?

Toughness has a rightful place on the business scene. But to know what that place is you have to understand its real nature. First, here is what toughness is not:

Throwing one's weight around. "We're the biggest taxpayer in the community," says a top executive, trying to wring a concession from community officials. (Even if he gets his way, he's storing up future grief for himself.)

Unreasonableness. "No, I won't listen to your explanation," says a purchasing agent to a supplier trying to account for a late shipment. (He thinks he is being tough-fisted but subsequent events are likely to show he is being soft-headed.)

Browbeating. Usually this is done to employes with the chin out-thrust, "So you think you can tell me how to run things . . ." (That chin is what he has to take it on when trouble arises and people who know the answers don't tell him how to run things.) Toughness does not rule out gentleness as a companion quality.

TWO UNTOUGH EXECUTIVES

Two example executives further demonstrate unfertile attitudes toward toughness. One takes the high road—the other the low. Neither arrives!

Executive A. "Give them an inch and they will take a mile," he says of his subordinate, and doesn't give the inch. Result: resentment and minimum cooperation.

Executive B. His policy is peace at any price, and the price is capitulation. No, he doesn't let employes walk all over him, but they get away with an awful lot. Result: employe relations are a mess as demands become increasingly unreasonable.

Neither Executive A nor B are exemplary:

Executive A thinks toughness means unrelenting pressure at all times. He bears down because he is afraid, afraid that if he eases up for a moment the work will suffer, people will get out of hand, etc.

Executive B isn't tough because he fears the consequences, in terms of ill will and strained relations.

While Executive B is afraid to be tough, Executive A is afraid not to be. Result: neither gains the advantages of appropriate firmness.

THE EFFECTIVE APPROACH

Behind the attitude of real firmness lies two principles:

1. Be clear about your stand or demand. To be firm means to work out clear-cut limits. Statement of limits or standards must be sharp, explicit. This principle, being clear on what you want, must be teamed up with another—

2. Insist on getting what you ask for. As one manager puts it: "If you don't see to it that people live up to the standards you set, don't bother setting them."

Toughness is not a matter of flying off the handle or blowing up. Real toughness always has a clear and logical connection to a specific state of affairs: you know what you want in a given situation; you communicate what it is; you insist on accepting nothing less.

Viewed in this light, the no-nonsense executive does not have a chip on his shoulder. He doesn't sport an air of bravado, but rather an attitude of knowing what is wanted and *how* it is wanted. Result: firmness emerges

as a systematic, non-emotional means of controlling a situation, of keeping performance at a desired level.

MASTERING TOUGHNESS

Perhaps there is a voice inside you which says, "If being hard boiled is not a natural part of your personality, how can you act tough without being phony?" The answer to this question lies in the following distinctions.

Acting vs. Being. We tend to think of toughness as requiring physical display—one must have a grim visage or a gruff voice, for example. This is not true. The tough executive may be emphatic—he is never bullying. It is possible to be hard boiled without frothing at the mouth.

People vs. Things. Second half of the secret is the target at which you aim the toughness—of particular importance in dealing with subordinates. Your words are directed not against a subordinate but against a fault—failing to follow a given procedure, for example.

If you say, "Your work is poor and must be improved," an employe can act for betterment. If you say, "You are incompetent," he has no recourse. Your targets become not Pete Jones or Bob Kent but—

. . . a failure to follow procedure;

. . . carelessness—for example, neglect of quality standards;

. . . failure to obey instructions.

Executives who know how to be tough in dealing with subordinates assert their firmness by a sequence of steps:

1. Tell the subordinate what is wanted. Whether it is a simple instruction or an explanation of a complex policy, your people must be set straight on the limitations or standards applying to their activities.

2. Call the subordinate's attention to any deviation. This must be done quickly. Any time lapse detracts from the firm approach. Perhaps in his work or behavior the subordinate has overstepped limits. You cite chapter and verse, telling him what he has done that is unacceptable, and why it is unacceptable.

3. Give him a warning. Remind him that he has repeated this fault, whatever it may be: "I spoke to you about this last week . . ." State the penalties: "If you repeat that behavior, it may be necessary . . ." and state what action may have to be taken.

In some situations, more than one warning may be in order. You may have to spell out the situation in simple block letters.

4. Take action. Whenever disciplinary or punitive action is in order, take it. Warnings that prove to be hollow lose their meaning and undercut your leadership position.

WHEN TO GET TOUGH

Toughness is a procedure to be used as and when needed. Specific situations call for your firmness. They are easily recognized:

- **When the individual or organization will not listen to reason.** If reason, logic, persuasion fail, the hard-boiled approach is your final resort.

- **When you're being taken.** You buy a service—let's say it's grounds maintenance—as does a competitor. You've been paying for gravel for road surfacing, and learn that your competitor has been getting his gravel gratis, simply because he pressures the supplier. It's a small item, but if you permitted this same laxity in other situations, you'd be in trouble. Therefore, you let the service company know you either get equal treatment, or you've come to a parting of the ways.

- **When big stakes are involved.** This may mean dollars and cents or a matter of principle. In either case undesirable consequences must come to a halt immediately. Cracking down gives you your best chance for a satisfactory return to normal.

Notice that implicit in each situation has been the recommendation that you assert your principles and stand by them. Such assertion is the most direct way to demonstrate that yours is an organization of maturity and integrity.

THE LANGUAGE OF TOUGHNESS

An old time cartoon shows a man smoking right next to a *No Smoking* sign. Staring at him in cold accusation is a policeman. Says the wrongdoer defensively, "It doesn't say 'positively'."

Here is illustrated one of the cardinal points of making clear a nonnonsense attitude. For some people, you must say *absolutely* to show you mean what you say. To others the most unadorned statement gets through perfectly.

What are the rules of language you must follow to (a) make your policy of toughness clear; (b) make it stick? Here are some concrete suggestions:

1. Strive for clarity and brevity. When it comes to asserting your views, the fewer words the better. The executive who goes on and on when he sets up a desired procedure or standard of conduct, is weakening and not strengthening his case.

2. Be specific. The tough executive, unlike his emotional counterpart, is effective because he is concerned with the realities of a situation. Where a non-tough executive might fly off the handle, indulge in wild generalities: "They never follow procedure . . . I've told them a hundred times . . ." etc., the tough manager sticks to actual details. In this way, he avoids vagueness and ambiguity.

He keeps people on track by talking in definite terms.

3. Be emphatic. Let your tone tell your story. Emphasis rather than threats tells people you mean what you say. You get emphasis by the simple device of talking directly to the individual, looking him straight in the eye.

4. Speak distinctly. The slurred, rushing output of words is a sign of anger. Sharp enunciation is the trademark of the tough speaker who gets impact into his message.

In the long run, the hard-boiled manager will win the respect and admiration of others. Everyone responds to decisive leadership. People want to know where they stand, they want limits set for them. Toughness accomplishes this—sharply, clearly, acceptably.

Once you accept the concept of toughness described here, you have at hand a reasoned and reasonable means of control. Policies and practices in every field may be influenced by the extent to which executives apply the principles of toughness.

When managers see toughness divorced from personal expression, many aspects of decision making, planning and implementation proceed more realistically. All companies must use firmness to some degree, since its complete absence means chaotic laxness.

Key Words for Indexing
Management, Personnel, Supervision

YOU CAN MAKE YOUR QUESTIONS PAY OFF

The question is one of the most used media of communication in the management of men—yet it is the least developed. Here's how the art of intelligent, effective questioning can improve your administrative ability

Dr. Richard Morley
Gulf Coast Junior College
Panama City, Fla.

The art of "questioning" reaches far back into man's past. In fact, questioning started with the very creation of man—and woman. Did not the serpent in the Garden of Eden ask, ever so cleverly, of Eve, "Yea, hath God said, Ye shall not eat of every tree in the garden?"

Since that questionable day in the Garden of Eden, man has asked and been asked billions upon billions of questions.

Statistics show that of all the communication media, man's personal conversation accounts for more than 50 percent of all information transfers. Surveys also prove that man's conversation is composed of about 40 percent of asking questions.

The hydrocarbon processing industry is an example of the fact that man is constantly seeking the unknown, the untried, the unseen. He is constantly searching and questioning to find what is over the mountain, across the sea, and in outer space.

Disturbing but true is the fact that man learns only through asking and finding answers to questions that plague him. Only by questioning other men's thoughts, ideas, actions, concepts, experiences, skills, theories and philosophies can man expand his own creative processes.

Key to Learning. The key to learning—beyond question—is the question. Questions make learning a dynamic and living process.

The art of questioning, however, is one that has been overlooked in recent years. Management and industry, seeking to improve their internal communications, have been barraged by seminars and studies on the art of speaking, the art of listening, the art of writing, and similar subjects.

In this attempt to improve communications, the art of questioning has been sadly neglected.

This has not always been true. Great men in history have known and perfected the questioning art. Voltaire once said, "Judge a man by his questions, rather than by his answers."

The philosopher Socrates became famous for his questioning method of

Why you should use the "Questioning" technique

- Research has shown that 40 percent of man's communication is composed of asking questions. So it stands to reason intelligent questions will improve idea transmittal.
- A carefully posed question demands a careful answer.
- Selective questioning makes you both teacher and learner. A question requires a response, whereas a flat statement asks no reaction from the listener. By getting others to answer questions, you stimulate them to tap the resources of their own minds. A lecture, one-way conversation, or direct order fails to negotiate the "two-way street" of communications.

To ask the right question . . . at the right time . . . reveals a superior degree of understanding. It is an indication the one asking the question knows what and why the question is being asked

teaching. Aristotle commented on the inability of man to describe anything without drawing questioning comparisons with something else.

Did not Jesus Christ, the world's greatest teacher, employ the question-and-answer method almost exclusively, even to the extent of many times answering a question with a question?

Questioning Is an Art. Make no mistake about it; there is as much an art to asking questions as there is to painting. Just as the skilled artist carefully selects materials and subject, the skilled questioner chooses ideas and words to achieve his purpose.

And the successful executive knows the importance of the questioning art. Business and industrial progress has constantly demanded increased leadership abilities in people who manage. One such ability is the questioning art.

There is no more far reaching implication to a man, once he becomes a leader, than to realize that to stay a leader he must depend upon all those who make up his department or organization.

Executives and management personnel, as never before, must rely upon associates and subordinates to get results. The executive who recognizes this also realizes that this assistance and maximum effort can be obtained only by asking for and inviting it.

Other Goals. Such executives also use the questioning art daily to reach other goals. Questions are asked to obtain certain bits of information, to piece together facts, actions, situations; to solve problems, to formulate opinions or beliefs, and to clarify the subject considered or discussed.

WHAT CAN QUESTIONS DO?

• **Questions provide a purpose and a direction.** The old saying, "A person with a question is a person with a purpose," holds profound meaning. A questioner may not know exactly where he wants to go when conferring with individuals or groups. But a few wise questions will soon plot his path. If the questioner already knows where he wants to go, carefully selected questions can light the way for others.

• **Questions force answers.** One amazing thing about the questioning art is that almost every question requires an answer. The asking for advice is usually disarming because man, by his very nature, seems compelled by some inner driving force to respond. In addition, a man takes pride in being asked for advice. He takes more pride when his advice or answer is received by a sympathetic and willing ear.

• **Questions make deep impressions.** In the give and take of question-answer sessions, both participants get a keener insight and impression of the conversation. Asking and answering questions sharpen one's mental abilities. Most people, moreover, seem to remember better "when they learn" through such sessions.

• **Questions require intelligent thought.** Asking intelligent questions is essential to getting effective results. This is so whether it be in a two-man conversation, a summit conference, or a large directors' meeting. To ask the right question at the right time reveals superior understanding. It has been said that "to ask the right question evidences half the knowing."

• **Questions can be a tool to train leaders.** In the management of men, where supervision is the position's primary function, the man experienced in the questioning art would never tell a man how to become a good supervisor. The experienced questioner would teach the man, using questions to force him into self-evaluation. It is a method used successfully by social workers, counselors and guidance workers. But it is also a method that can be profitably used in business and industry.

• **Questions can create the proper atmosphere.** Intelligent and directed questions, timed and produced into conversation, speech or conference, can create the atmosphere the questioner wants. Through gradual use of a series of questions, the skilled questioner can persuade a group to accept ideas or changes that might have shocked had they been suddenly sprung upon the audience.

Some Points to Remember. Sometimes it is necessary to restate a question, in different words, when the first question has not been well answered. Questions can be repeated for emphasis, clarification, agitation, or to get a satisfactory answer.

The skilled questioner should ever be alert to the other man's questions and use them to get information. The other man's questions should be answered intelligently and concisely. However, when possible and to a definite advantage, one may counter with an additional question in his answer.

THE QUESTIONING TECHNIQUE

All fine and good, you say, but "how can I develop or improve my questioning ability?"

To develop the skill of asking questions, a man must first have a strong sense of curiosity. This strong curiosity is characteristic of a vigorous mind. The curious man is usually one on his way up or one who has already reached the top and intends to stay there.

• **Plot the questions.** The successful questioner also plots the questions to be asked so the conversation will move in the direction that will give the answers. Once solutions have been determined and established, the questioner may wish to project the thinking. He can do this by asking speculative questions that may border on fancy, fantasy, or fact—yet provide solutions meriting study for future research and development.

• **Review.** The questioner should carefully review the types of ques-

tions he plans to use and their purposes. Does the questioner want to obtain facts, to provoke thought, to inspire, to learn opinions, or to move to action? Does the questioner wish to employ the rifle method—in which he questions certain individuals, or the shotgun method—in which he questions the group.

• **Look at your listener.** Certainly, the questions should always be directed straight to the party concerned —not to the ceiling, floor, wall or window.

• **Control your voice.** To improve questioning ability, remember that the tone of a man's voice affects the answers he gets. The old saying that "a great percentage of man's difficulties in life are caused by the tone of his voice," holds true today.

• **Control your gestures.** The questioner should also develop gestures or facial expressions in mastering the questioning art. The lifted eye-brow symbolizes a question in any man's language. In like manner, questions by a frown or whimsical smile almost always brings the desired answer.

• **Use a tape recorder.** If possible, the questioner should tape-record several meetings and conversations—then listen carefully to the play-back in private. If he really wants to improve his questioning ability, he can easily detect flaws in his techniques. It will show him how often he speaks, how little he listens, how often he interrupts, how he may dominate the discussion, and how intelligent or unintelligent are his questions and explanations.

• **Plan ahead.** When to question must ever be conscious in the questioner's mind. When to inject a question, when to interrupt, when to question for related data, when to question for ideas, when to question for evaluation, and when to question for summarization can be regulated by careful pre-planning.

• **Use the five "w's".** The faithful and reliable five "w's" of journalism are the key starting activators to the questioning art. *Who, when, where, what, why* and sometimes *how* form questions in their sole use, but the skilled questioner attaches other words to clarify the question.

• **Stay alert.** Above all, the skilled questioner trains himself to be ever alert during a question-answer session. In such a give-and-take situation, failure to keep alert could wreck the session. In the questioning art, man brings into full play the mental processes which he has.

• **Thwart the egotist.** There are persons in such situations who use the question to bring attention to themselves. They try to build their ego, or to derive self-glory in posing questions which only stifle and hinder conversation.

The experienced questioner can readily recognize and categorize this type of question. He can cope with such a person by answering with a leading question that must be answered. Often, an additional question before the first is answered forces the heckler to find himself and his place.

• **Be relaxed.** Furthermore, an appearance of relaxation, calm, and sincerity on the questioner's part lessens tension and brings about a more successful conference or conversation.

Once man has obtained mastery of the questioning art's primary techniques, he must know what to do with results. The skilled questioner must know when his questions have been answered satisfactorily.

• **Analyze answers.** The questioner must analyze, classify, divide, separate, and synthesize the answers he has obtained. This post-questioning period allows the questioner to frame a pattern that gives formation and direction to the problem or situation.

The executive who challenges his people to think must use his people's thinking in decisions to be made. When sincerity is the keynote of the question asked, sincere answers usually result. The sincerity must be carried through to whatever application or use is made of the information received.

Although all answers and ideas will not be useful right away, they will form a reservoir of ideas to work with in the future. The astute executive will learn to develop his people so that the flow of ideas invited will continue.

• **Exercise your mind.** To develop the questioning art to full perfection, man must call upon his total mental processes and powers. The individual practice arena for developing the questioning art lies within man's own mind. And, his own mind is his workshop of rationalization.

• **Practice.** Like many other things, the art of questioning improves with practice. Through mastery of the questioning art, however, a man can become a better executive, leader, supervisor, worker or individual. Through questions, man can better understand and lift both himself and his associates.

About the Author

Dr. Richard Morley is president of Gulf Coast Junior College, Panama City, Fla., where he introduced the state's first general-engineering technology program this year. Prior to his present position, he served three years as technical dean at Pensacola Junior College, Pensacola, Fla. His work there led the school in becoming the first junior college in the nation to obtain an Atomic Energy Commission license, operate a sub-critical reactor, and offer a nuclear technology program. A native Texan, Dr. Morley received his B.S. and M.E. degrees from Trinity University, San Antonio. He obtained his Ed.D. degree from the University of Houston, and has majored in psychology, educational administration, journalism and guidance.

Key Words for Indexing

Communications
Supervision
Personnel
Reports
Management

Test Yourself on Labor Relations

No. 1. Is 'Speedup' a Must?

The department was having a real problem. Employes were not following instructions. Finally, management issued the following statement:

"The foreman directs the working force and he will tell you what is required to do a quality job. We expect you to follow his directions and orders. If anyone does not . . . they will be suspended."

A week later the supervisor noticed that Harris seemed to be dawdling on his job. He told Harris to "speed up your work." Harris ignored him—and continued at the same pace. The foreman then suspended the worker for five days. Harris took his case to arbitration, stating: "I've been working at my regular pace, which has been established for some time. The foreman is trying to change the standard. He wants me to work faster than I did before. Why? My work was good enough in the past. Now he says 'speed up'. I don't feel it's fair for him to change the standard without discussing it with my union."

The foreman answered. "We have to improve our efficiency. I've been told to see that employes keep up their end of things. It's my job to decide whether workers are doing their part or not. We have no rigid standards of performance. When I need the production, I want employes to cooperate and work faster. That's not unreasonable. Besides, if the worker is dissatisfied with my order, he can use the grievance machinery—not just stand there and disobey."

Test Yourself:

Was the supervisor: Right ☐ Wrong ☐

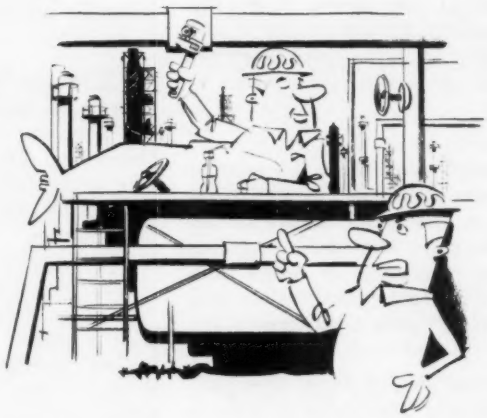
No. 2. Strikers and Vacations

The company and union couldn't agree on a new contract. When an impasse developed, the union called a strike which lasted 10 weeks. The employes returned in June, and put in for vacations scheduled for July and August. These requests were turned down cold. Management said:

1. Vacations are for rest. You have been resting 10 weeks.
2. Vacations are given to employes in "continuous employment." That means employment without break, cessation or interruption. You weren't absent because of illness. You left voluntarily.
3. Vacations are like wages. You don't get wages while on strike—then why expect vacations?

The union came back with these answers:

1. This strike was legal. We couldn't reach an agreement so we walked out. This is part of the collective-bargaining process.



2. The strike did not terminate the employes' status as employes.
3. If you deny them vacations, you are discriminating against them for doing what they had a right to do under State and Federal Law.
4. Vacation is not a gift. It is an earned right to which employes are entitled. Nothing in the contract says they have to work a specified number of days to earn that vacation.

Test Yourself:

Was the union: Right ☐ Wrong ☐

No. 3. Refuse to Wear Safety Gear

The company had a safety problem. Employes were not wearing their safety hats and safety shoes in necessary areas. The difficulty was that the workers shifted from one spot to another, and safety equipment was not necessary in some parts of the plant.

In order to ingrain the safety habit, the company passed a rule that employes had to wear safety gear "100 percent of the time on the job."

There was a storm of protest from the workers. "Safety equipment is burdensome," they said. "Besides, it's unnecessary in some areas where we work. You can't force us to wear hard hats and safety shoes where conditions don't warrant them."

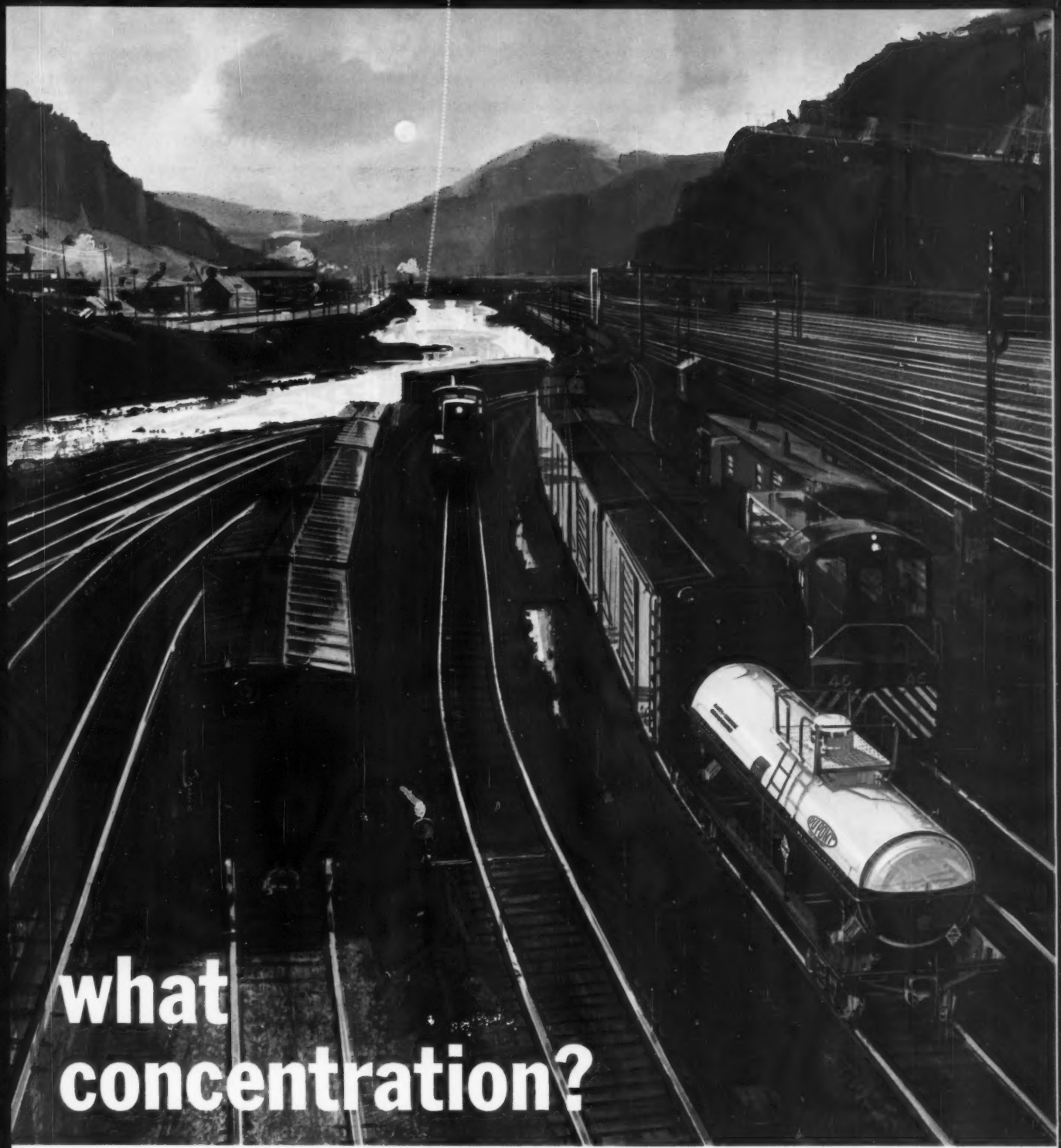
The company replied, "The only way we'll get necessary compliance is a blanket rule. We have a right to determine when and where safety equipment should be worn."

As the employes argued and balked, the company finally suggested that an arbitrator be called into settle the issue. The employes went along with this suggestion.

Test Yourself:

Was the company: Right ☐ ☐ Wrong

Answers on page 221



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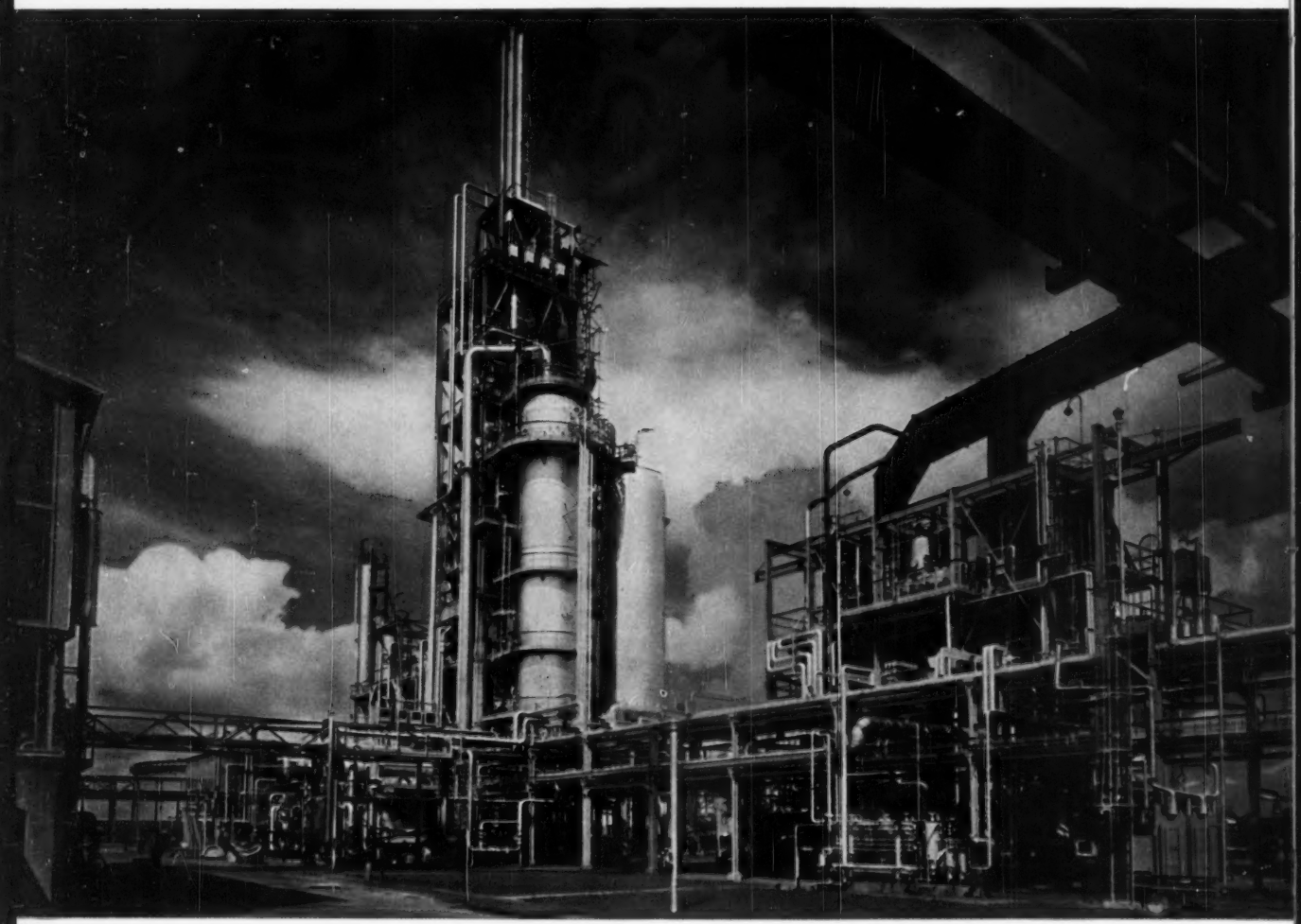

429

Hydroformer plant of ESSO AG. at Hamburg-Harburg

Distillation of petroleum, synthesis oils, and tar oils under atmospheric pressure, under vacuum and high vacuum.

Stabilization and redistillation of gasoline and benzole.

Thermal and catalytic cracking processes.

Thermal and catalytic reforming processes for the conversion of heavy naphta into high octane gasoline.

Hydrorefining and hydrodesulphurisation of gas oil, gasoline and benzole.

Electrostatic dehydration and desalting of crude oils.

Refining of lube oils with wax recovery.

Production of synthetic fuels, waxes, hard wax and alcohols.

Absorption of propane-butane and gasoline from gases.

Recovery and processing of liquefied gases (LPG) and pure hydrocarbons by fine fractionation.

Chemical or extractive refining of liquefied gases (LPG), gasoline and diesel oil.

Polymerization of propylene-butylene to produce gasoline.

Cracking of crude oil and light petroleum fractions.

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(Answers to Quiz on Page 218)

CASE NO. 1

Arbitrator Harry H. Platt ruled: "The evidence convinces me that the discipline was proper. The aggrieved employe flatly refused to follow the foreman's instructions to speed up. There was nothing unreasonable in the request. Where a contract prescribes a grievance procedure for the resolution of disputes arising under it, employes do NOT have the right to resort to self-help. The very purpose of the grievance procedure is to provide an orderly method of testing the correctness of conflicting interpretations of contract language and of rights and obligations. Its basic aim is to prevent a disruption of production. The employe was properly disciplined. The grievance is denied."

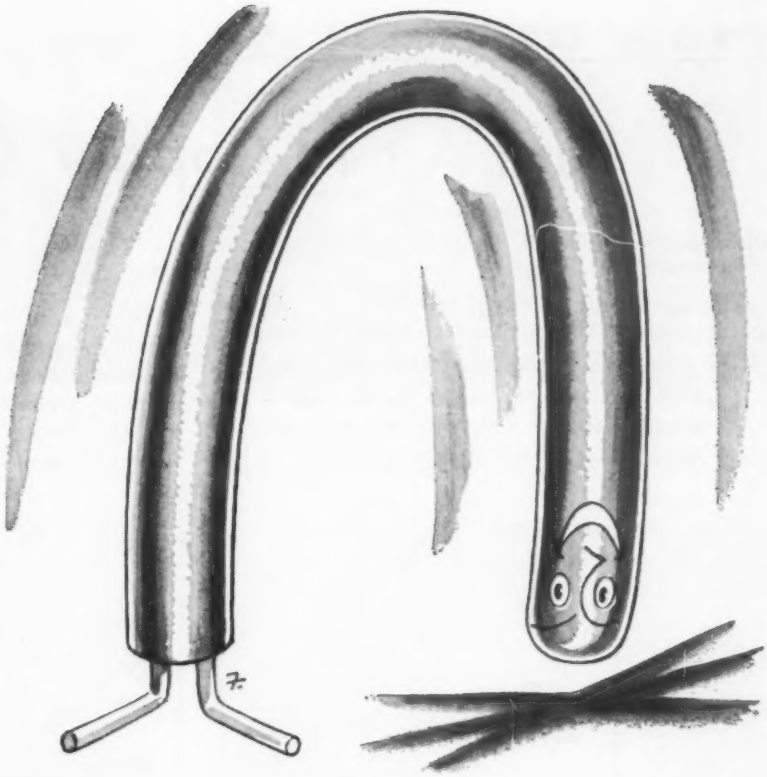
CASE NO. 2

Arbitrator Stanton W. B. Wood ruled: "The company's argument that strike participation produced a break in continuous employment lacks validity. It is not just and proper cause for denying its workers the paid vacations to which they were rightfully entitled. Furthermore, no language, expressed or implied, in the agreement could lead to finding that any employe who participates in a legal strike shall be deemed to have abandoned, quit or otherwise created a break in his continuous employment. The employes are entitled to be given their paid vacations.

"Our findings here do not forever bar the door to future opportunities for the company to press their position to a successful conclusion. Their remedy lies in subsequent collective bargaining."

CASE NO. 3

Arbitrator Joseph Shister ruled: "It may well be true that in the area where an employe normally works there is no need for a safety hat. But the fact remains that the employe may, from time to time, have to go to other areas where the hat is needed. Experience shows that unless the requirement to wear the hat is made uniform, the employe may easily forget to put it on when moving into a so-called 'danger area.' While the guards are not the most comfortable coverings in the world, they do not impose any undue physical burden on employes who have to wear them. The company does have the right to institute safety rules unilaterally."



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How to Do It...

Find Air to Copper Sweeten

Haim Doron, Arthur G. McKee & Company, Cleveland, Ohio

This nomograph will help you figure the stoichiometric amount of air needed for copper sweetening.

The sweetening reaction and regeneration steps are:

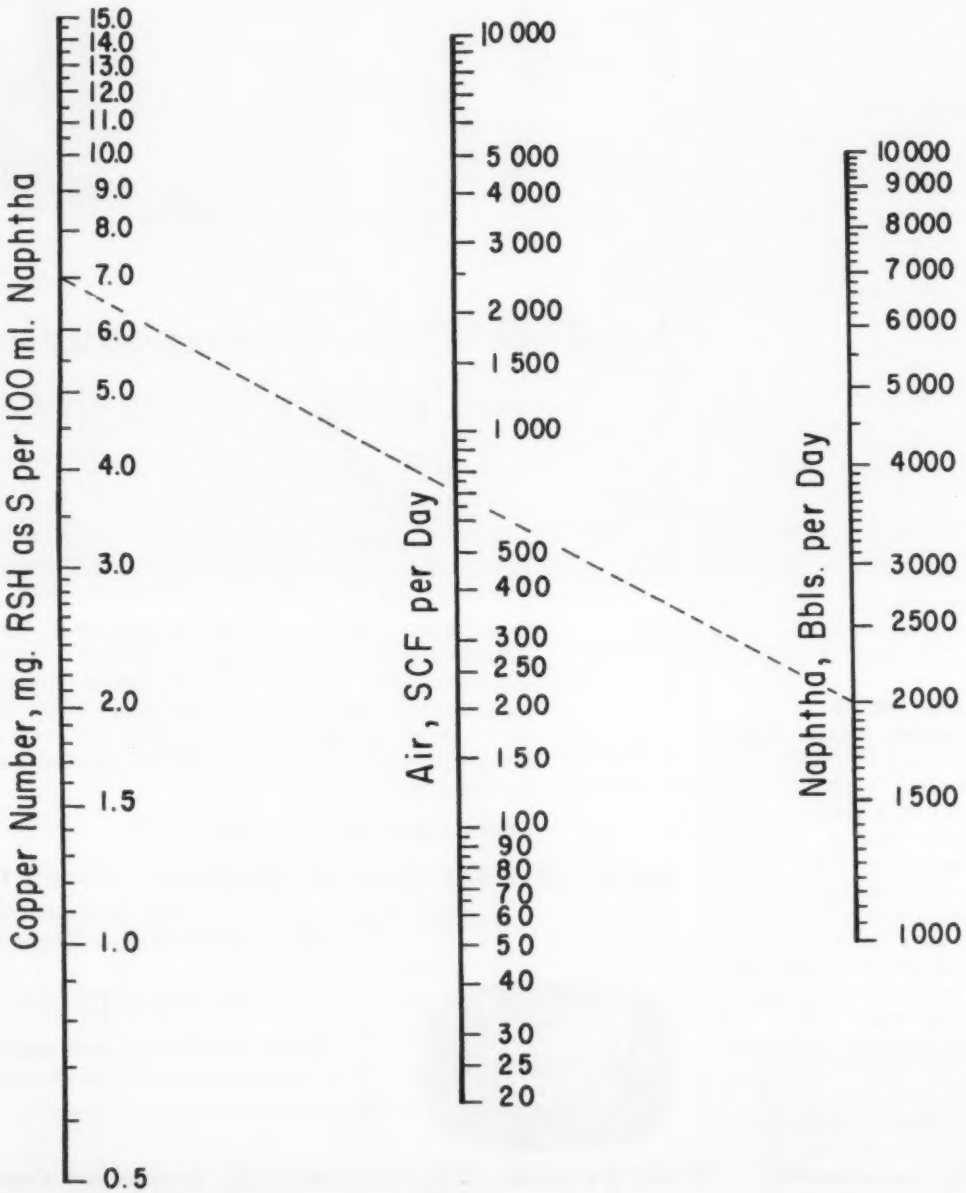
$$2RSH + 2CuCl_2 = RSSR + 2CuCl + 2HCl$$

$$2CuCl + \tfrac{1}{2}O_2 + 2HCl = 2CuCl_2 + H_2O$$

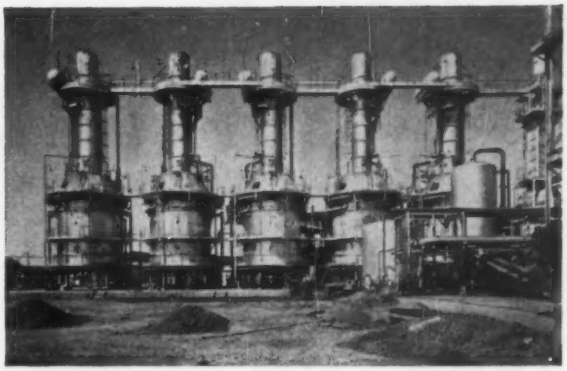
In the nomograph the mercaptan content of the naphtha charge is reported in "copper number" and is equal.

(1,000) (% Mercaptan Sulfur) (Naphtha Sp. Gr.)

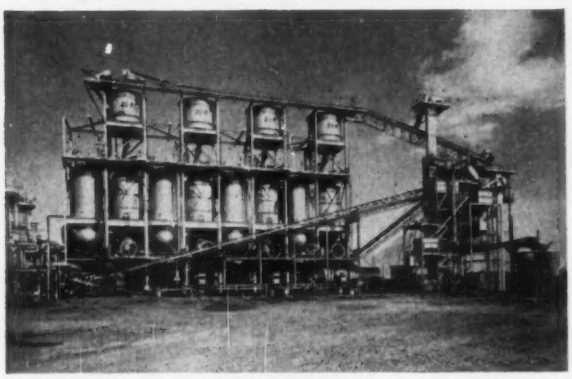
For practical purposes, as much as four to five times the stoichiometric amount of air is recommended at operating pressures of 60 psig and higher. For mercaptan sulfur under 0.05 weight percent of charge, a minimum air rate of 5 scf/bbl should be used. ##



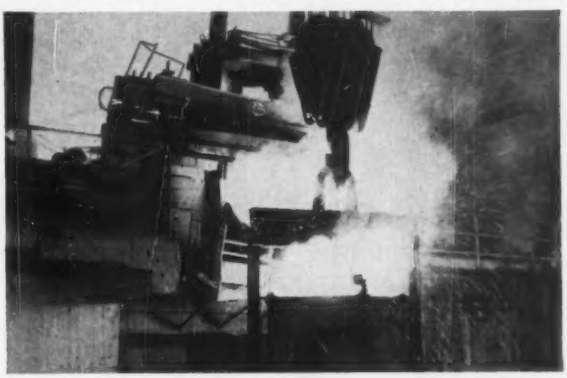
Step 1. Ore preparation. First step in Sponge Iron Process starts with Pihuamo and Durango ores being crushed and screened to ¼-1½ inch sizes. Ore is then poured into batch-type reactors. Some ores are first roasted to lower sulfur content.



Step 2. Natural gas is converted into hydrogen by catalytic steam reforming. After pre-heating and mixing with steam, the gas flows through heat-resistant Incoloy alloy tubes, which are heated to temperatures of 1400° to 1800°F.



Step 3. Direct Reduction. Process gas containing 85% hydrogen passes through reactors loaded with ore, removing 90% of the oxygen and 85% of any sulfur present. Reduced product averages 85% metallic iron, 15% iron oxide.



Step 4. Reduced ore to steel. Electric-arc furnaces melt the reduced ore to steel. The rimming and low-carbon steel ingots produced are exceptionally free of contaminants and have excellent qualities when converted to steel products.

Producing hydrogen for new iron ore reduction process...

Incoloy alloy tubing withstands furnace temperatures of 1400° to 1800° F

A new chemical process makes possible economical steel production by direct and continuous reduction of ore to sponge iron.

Developed by Hojalata y Lamina S. A., a leading Mexican steel producer, with engineering assistance from the M. W. Kellogg Co. of N. Y., the process involves the reduction of iron ore by hydrogen gas.

Steam-Methane Reforming is used to produce the all-important hydrogen. In the high temperature process, feed-gas—in vertically suspended tubes—is mixed with steam and heated at temperatures of 1400° to 1800°F. Operating pressures run as high as 125 psig.

To meet these demanding service conditions, extruded tubing of Incoloy* nickel-iron-chromium alloy was specified because of these specific advantages:

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- Good weldability
- Freedom from sigma phase formation. In critical 1,100 to 1,600°F range, Incoloy alloy retains its ductility and impact strength.

If the selection of furnace tube materials is your responsibility, detailed information on the advantages of Incoloy alloy is yours with the helpful booklet, "Incoloy Extruded Tubing in the Petrochemical Industry." Just write to:

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How to Do It . . .

Simplified Calculations For Dilution of Dispersions

In the laboratory or plant, it is sometimes desirable to be able to dilute a concentrated polymer dispersion or any type of dispersion without the convenience of a slide rule. It may also be necessary to blend several dispersions of varying concentration to give a specific concentration. The following methods are recommended where rapid calculations are necessary:

Problem. Dilute a material of 40 percent total solids to 15 percent solids concentration. The answer may be obtained using figures as given in the problem.

Answer. Take 15 parts of concentrated material and dilute to a total of 40 parts.

Problem. Combine a dispersion having 40 percent solids with that of a dispersion having 5 percent solids to give a product having 15 percent solids.

Answer. Take difference between:
40 and 15 = 25 parts of 5 percent solids
15 and 5 = 10 parts of 40 percent solids

Read as follows: use 25 parts of 5 percent solids material and 10 parts of 40 percent material to give a material having solids of 15 percent.

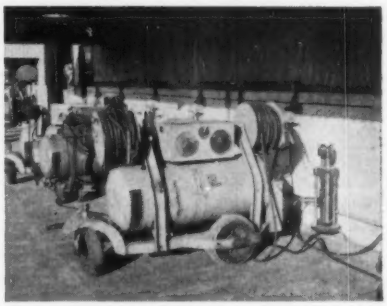
The above illustrations, of course, are applicable to any figures. These techniques have greatly simplified calculations in problems where dilutions are necessary.

Item submitted by Henry Merken, Polyvinyl Chemicals, Inc., Peabody, Mass.

Put Welding Machines Outside and Cut Noise

At the Continental Oil refinery in Westlake, La., a lot of noise is eliminated in the welding shop by having the welding machines placed outside the shop. This also makes them readily available for work inside the plant.

Receptacles (440 V.) are placed along the outside of the building to power the electric welders and nearby plugs are placed to connect up the welding current. Other plugs are placed near each of the welding tables on the inside of the shop so that the current is readily available without having the noise. When it is desired to use the welder in the field,



it is plugged into a receptable and the usual welding cables are used to reach the welding area.

Surplus Aircraft Service Stand Used in Valve Repair

Hydraulically operated aircraft

$$ Your Ideas Are Valuable! $$

At least $10.00 will be paid for each idea accepted for "How to Do It." All you need to do is write a brief note telling about your idea, then attach a photo or sketch (if needed), and mail it to Editor, Hydrocarbon Processing & Petroleum Refiner, P. O. Box 2608, Houston.

The conduit that beat 35 years of tough, atmospheric corrosion

For 35 years, beneath the suburban passenger cars of the Illinois Central Railroad, Alcoa® aluminum conduit took the toughest torture Chicago's industrial atmosphere could provide.

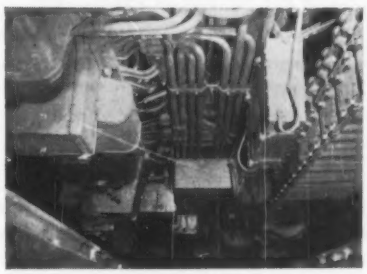
35 of Chicago's blistering summers. 35 of Chicago's blustering winters. Snow. Ice. Rain.

And only the labels were destroyed.

For 35 years this aluminum conduit has been protecting the cars' electrical system, located beneath the cars where they are subjected to most severe service conditions.

The aluminum conduit shrugged off atmospheric attack. Still on the job, it is delivering the same effective protection as the day it was installed.

Perhaps you can benefit from Alcoa aluminum conduit's corrosion resistance, lightness and strength in your plant. Contact your Rome-Alcoa representative, or write Rome Cable Division of Alcoa, Dept. 19-61, Rome, New York.



The Alcoa aluminum conduit beneath this Illinois Central car has been in operation since 1926—and only the color has changed.

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Sodium Borohydride Treatments Stretch The Useful Life Of Glycols, Cut Your Costs!

This is an economy angle that's important to consider. Sodium borohydride gives important new "life" to glycols and polyglycols that are contaminated with trace carbonyl impurities . . . quickly, without any complicated reprocessing. Just add small amounts of sodium borohydride powder — or liquid solution (SWS). Within a short time, in some cases less than an hour, most of the unwanted carbonyl is reduced to the alcohol*, like this:

$$NaBH_4 + 4RCHO \xrightarrow{2H_2O} NaBO_2 + 4RCH_2OH$$

If you manufacture glycols, it will pay you to improve the purity of your product by adding sodium borohydride directly to the process stream — or, by using sodium borohydride pellets for fixed bed purification. Doing it either way will give you the purity you want — without adding any significant cost to your overall process!

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*Patent #2683721 — owned by Metal Hydrides Incorporated

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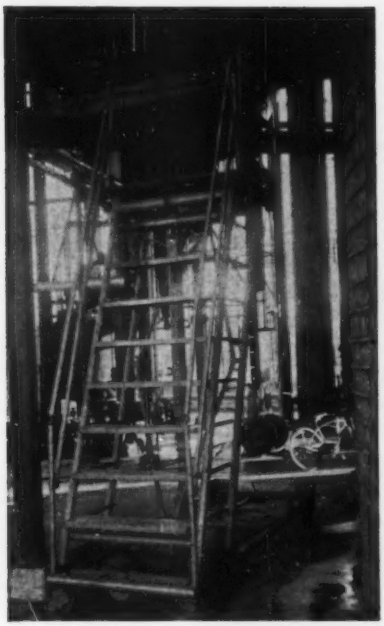

service stands (purchased as government surplus) can be very useful for working on overhead valves and pipes in processing plants. When not in use, they can be collapsed and stored in a convenient place out of the way. Yet, when they are needed, they can be wheeled out by one man and the platform jacked up for use in working on the overhead piping.

Modified Monkey Wrench Makes Ideal Spanner

Bungs on drums supplying lubricants, etc. to pump houses often vary in size, which means having a different spanner wrench for each size.

This problem is solved by using an old monkey wrench. Drill a 3/16-

inch hole at the inside outer corner of each jaw, then drive in a steel pin or dowel so it projects about 5/16-inch above jaw surface, and you have an adjustable spanner wrench.

Idea submitted by: Harry J. Miller, Sarasota, Fla.

In July, 1957, a leading refinery in the Midwest slap-troweled Purotab castable into a hex-steel facing of a flue gas regenerator duct to make a ¾" to 12" lining.

Now after more than three years on line, this Purotab lining remains serviceable with very minor patching.

Performance like this shows the value of a premium refractory castable designed especially for extreme erosive conditions. Purotab is a high-alumina castable containing a high-purity, high-strength binder. It creates an extremely dense, hard-surfaced lining serviceable to 3400 degrees.

The very low iron content of Purotab makes it suitable for long service in the reducing atmospheres of refinery cyclones, regenerators, and lines—wherever duty is most severe.

For full details about Purotab and other Kaiser refractories for the petroleum industry, call or write Kaiser Refractories & Chemicals Division, Kaiser Aluminum & Chemicals Sales, Inc. (Canadian Subsidiary: Refractories Engineering & Supplies, Ltd.)

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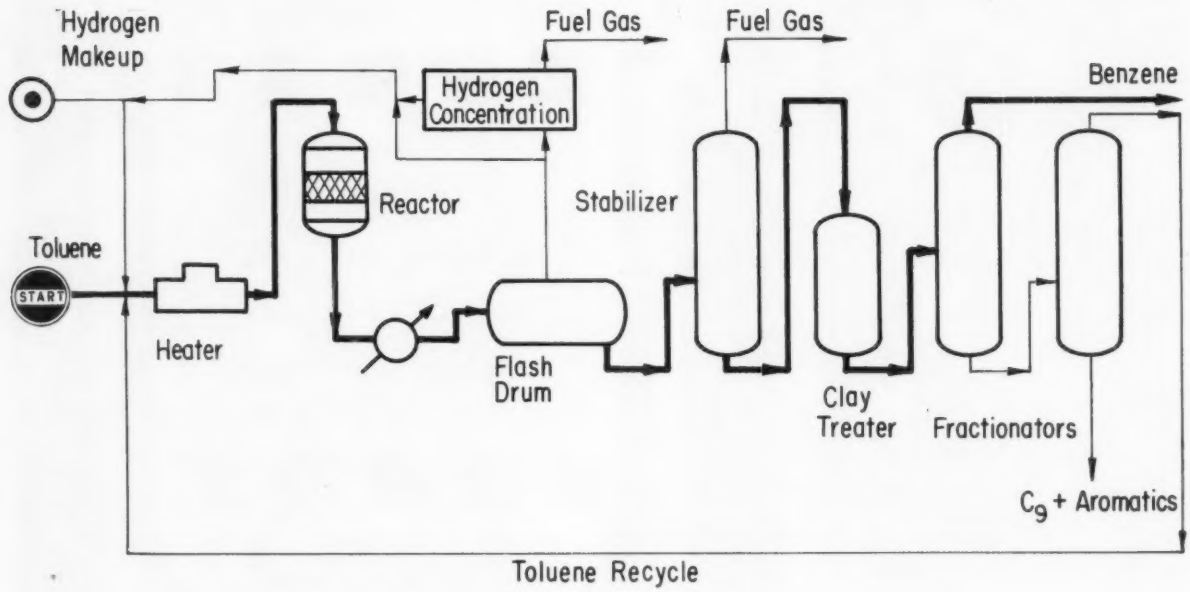


Benzene From Toluene by Detol Process

Crown Central inaugurates the new process at its Pasadena, Texas, plant

Now through a new catalytic hydrodealkylation process it is possible to produce close to theoretical yields of benzene from toluene and xylenes. The process, called Detol, has been developed by Houdry Process Corp.

The first license for the new process has been granted to Crown Central Petroleum Corp., and the first plant is scheduled to go on stream in July at Crown's Pasadena, Texas, facility. The unit has been designed to produce 17 million gallons of benzene per year.

This process is a highly selective one and may be used for dealkylating either pure toluene and xylenes or those containing paraffins, olefins and sulfur compounds (such as thiophene). The impurities are converted to light hydrocarbons and hydrogen sulfide.

Benzene produced by the Houdry system will have a freeze point of 5.4°C or better. The product will meet the required acid wash and corrosion tests, and if thiophene is present in the feed, the benzene will contain less than 1 ppm of thiophene.

Description. Toluene (or xylenes) is heated by both heat exchange and a heater to 1,000—1,200°F along with a hydrogen-containing gas stream composed of recycle hydrogen plus a hydrogen containing make-up gas (for example, reformer off-gas which contains 65 percent or more hydrogen).

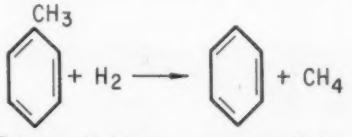
The mixture is then passed over a dealkylation catalyst. Process pressure varies between 500 and 1,500 psig, depending upon purity of the make-up hydrogen gas stream, composition of charge, efficiency of hydrogen stream concentration if such a step is used, and associated process economics.

The reactor effluent is cooled by heat exchange; benzene and unconverted toluene or xylenes are condensed and then transferred to a simple high-pressure flash drum.

In the latter, the major portion of the materials boiling below benzene are flashed, whereas the condensed unflashed benzene, toluene or xylene is pumped to a stabilizer, where the remaining dissolved hydrogen, hydrogen sulfide and light hydrocarbons not removed in the flash drum are stripped out.

When benzene must meet acid wash color specifications, the stabilizer bottoms are passed through a fixed bed clay treater, and the recovered liquid is then distilled to make the desired specification benzene.

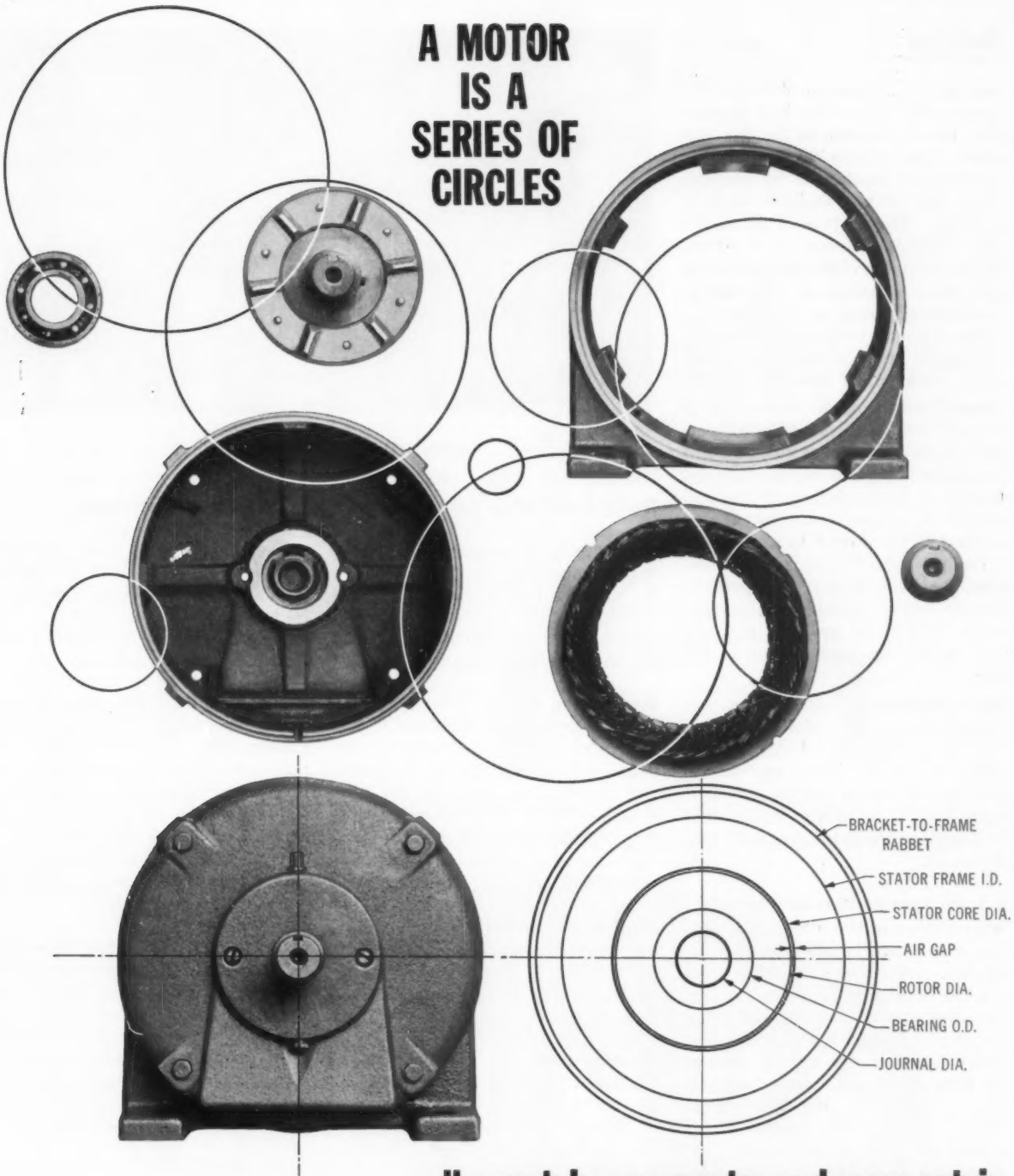
Unconverted toluene or xylenes are



further distilled in a simple column to remove a small quantity of high boiling by-product material and are then recycled back through the catalyst with the fresh feed.

Hydrogen. It is frequently desirable to include a hydrogen concentration

A MOTOR IS A SERIES OF CIRCLES



all must be accurate and concentric

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step to treat a portion of recycle hydrogen stream from the high pressure flash drum as shown in the flow diagram. The advisability of including this step is a function of the quantity, purity and price of available make-up hydrogen. The purpose of the hydrogen concentration step is to insure the maintenance of the desired hydrogen partial pressure in the system. Concentration may be achieved by a molecular sieve type unit, a cyrogenic differential condensation unit, or any other economically operable process.

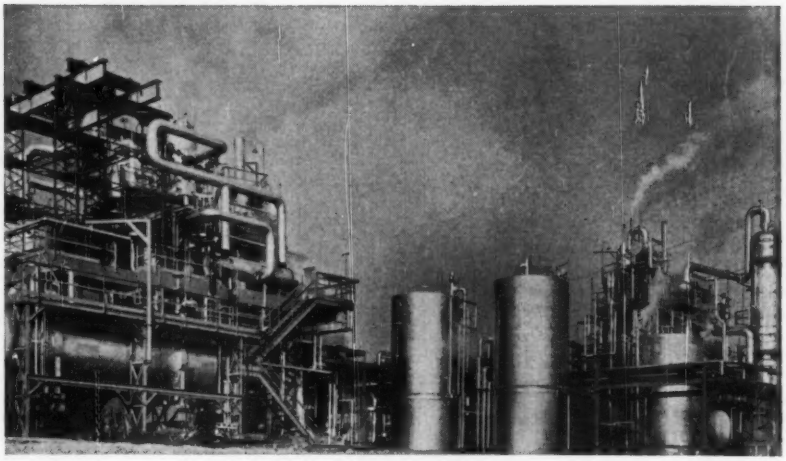
Conversion. Benzene in the reactor effluent yield is about 96.5 mol percent of the fresh toluene charge. Plant investments depend upon capacity, feed stock, hydrogen feed stream, and the like. Also, possible integration with existing facilities must be considered.

Utilities required per gallon of toluene feed are: steam, 11.3 pounds; electric power, 0.207 kwh; cooling water T30°F, 50 gallons; and net fuel production amounts to 21,700 Btu.

Operating Costs. It is estimated that operating costs in the Gulf Coast area will be approximately 1.63 cents per gallon of charge. These operating costs include direct charges for labor, supervision, operating supplies and maintenance, utilities, catalyst and chemicals.

E. I. du Pont de Nemours and Co., will construct a new plant at Orange, Texas, to produce high-pressure polyethylene and a new vinyl resin, a copolymer of ethylene and vinyl acetate. The new polyethylene unit will bring Du Pont's overall polyethylene capacity to nearly 400 million pounds. Du Pont also manufactures low-pressure polyethylene, the more rigid variety of the plastic, sometimes described as high-density polyethylene. The plant, to be built at the company's Sabine River works, is scheduled for completion in the third quarter of 1962.

U.S. Industrial Chemicals Co., a division of National Distillers and Chemical Corp., has placed an ethyl ether refining unit on stream at its Tuscola, Ill., petrochemical complex. The new unit produces absolute ethyl ether meeting the new specifications adopted by the American Chemical Society.



Annual capacity is 20 million pounds.

Reichhold Has $4-Million Maleic Plant on Stream

Reichhold Chemical Co.'s new maleic anhydride plant at Elizabeth, N. J., is in full operation. The $4-million plant, engineered and constructed by Badger Manufacturing Co., is located adjacent to a new $5-million fluid bed phthalic anhydride plant completed in 1960 by Badger. The facility has a design capacity of 20 million pounds per year.

It is based on Reichhold's own maleic production process.

Monochem, Inc., a joint venture of Borden Co. and U.S. Rubber Co., has awarded contracts to Chemical Construction Corp. and United Engineers and Constructors, Inc., for the construction of its new acetylene and vinyl chloride monomer plant at Geismer, La. Cost of the project is over $20 million.

Quaker State Oil Refining Corp. has chosen Foster Wheeler Corp. to build a liquid propane unit at St. Marys, W. Va. Completion date has been set for the end of 1961.

Westland Oil Co. will construct a 1,500-bpd Unifining unit at its Williston, N. D., refinery. Upon completion of this unit, the refinery will be capable of treating 3,000 bpd. Estimated cost of the project is $300,000.

The Dow Chemical Co. has placed a polypropylene plant on stream at Torrance, Calif., to produce 12 million pounds per year. The company has a small unit for polypropylene production at Midland, Mich.

Shell Chemical Co. has completed a new unit at Norco, La., using the first commercial application of the Shell-developed acrolein-hydrogen peroxide route to glycerin.

Ansul Chemical Co. plans to construct a petrochemical plant at Lake Charles, La., to produce about 60 million pounds of methyl chloride annually. Cost of the new facility, which will be owned 50 percent each by Ansul and Continental Oil Co., is over $1 million. Work is expected to begin immediately, with completion scheduled for early 1962.

Standard Oil Co. of California's partially completed Hawaiian refinery is presently running 20,000 bpd through its crude battery, while construction proceeds on the remainder of the units. Also, construction has started on a 6,600-bpd refinery in Peru. Standard-California holds a 35-percent interest in this project.

Foote Mineral Co. has begun making commercial shipments of butyl lithium from its new plant in New Johnsonville, Tenn. The facility is designed to produce about 100,000 pounds per year of n-butyl lithium.

Tidewater Oil Co. has selected Bechtel Corp., San Francisco, as prime contractor for the construction of its West Coast Isocracking plant at its Avon refinery in the San Francisco Bay area. Construction of the plant, which will cost over $20 million, is

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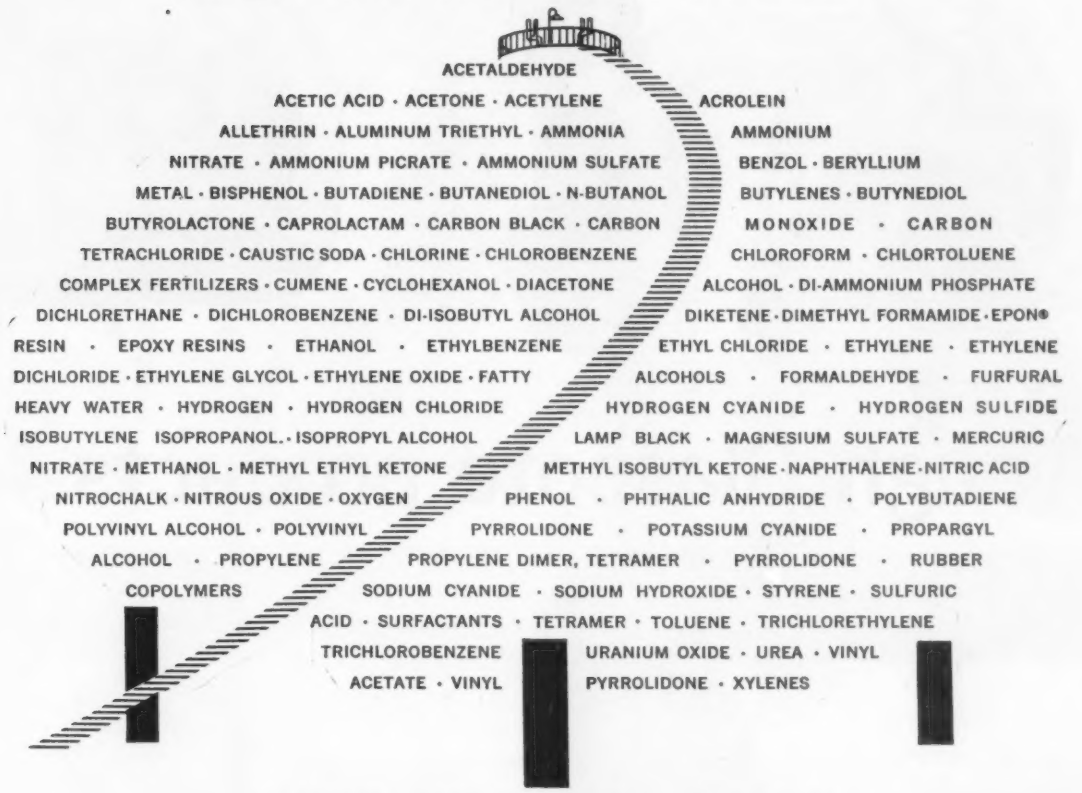
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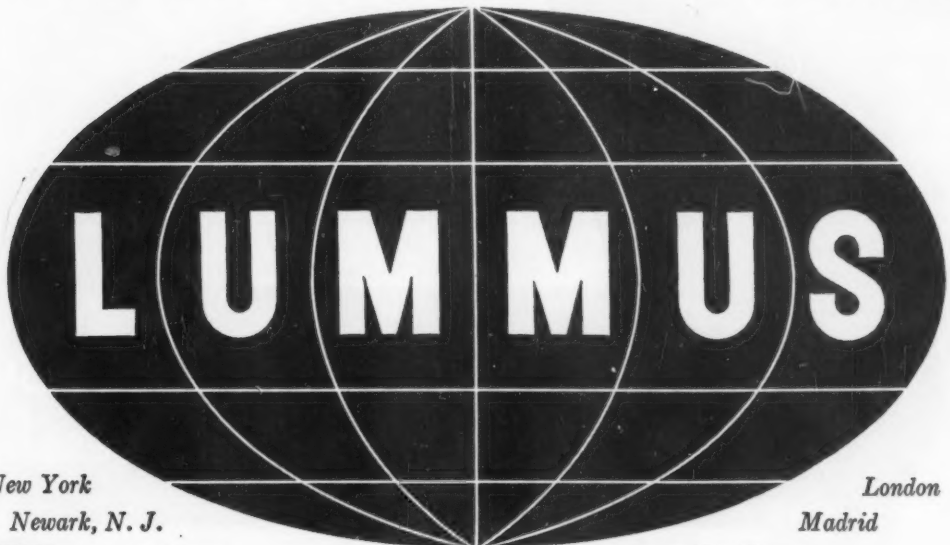

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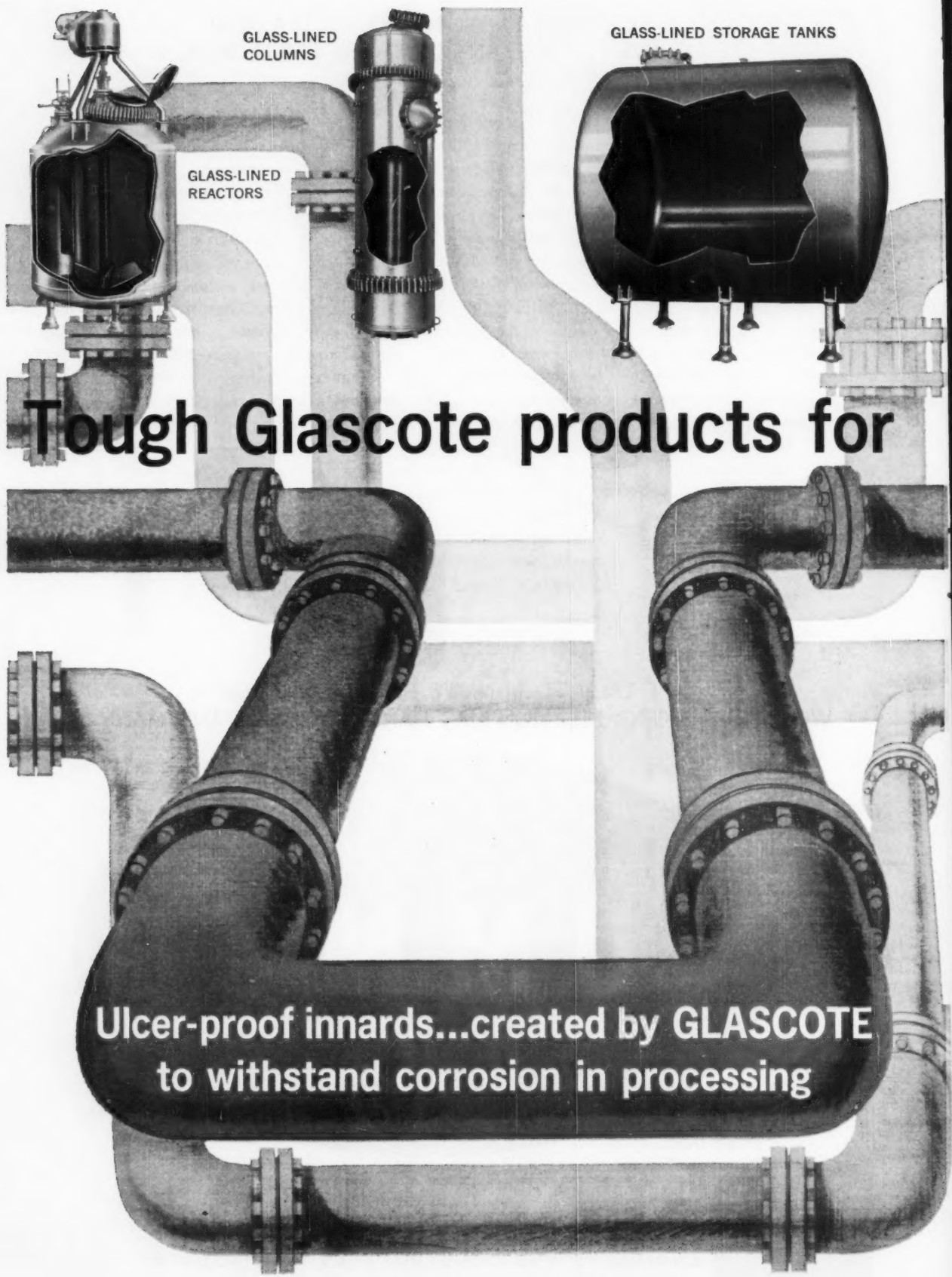
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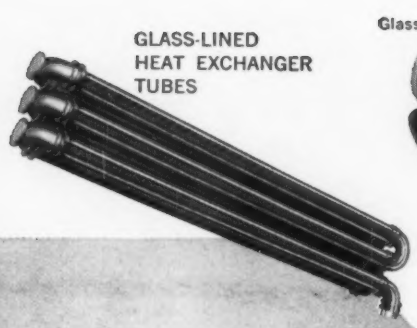

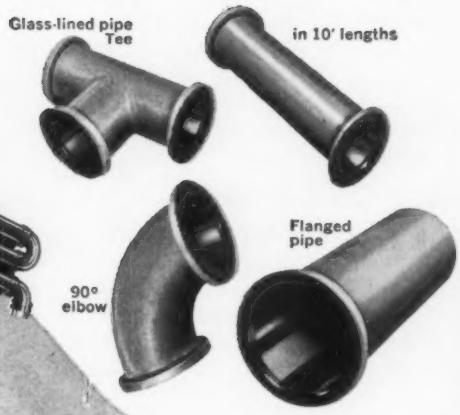

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Building . . .

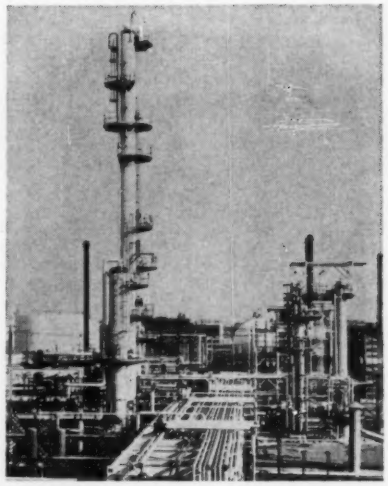
slated for completion in mid-1962. The facilities will include a catalytic pretreater unit and an Isocracking unit, each sized at 20,000-bpd, plus a 50-MMcfd hydrogen generating plant, and other auxiliary equipment. The new process will be licensed from the California Research Corp.

Phillips Petroleum Co. has placed a new 25,000-bpd heavy oil cat cracker in operation at its Phillips, Texas, refinery. The unit permits selective cracking of different feedstocks ranging down to the heaviest portions of crude oil. It increases the refinery's production of high-octane motor fuel and distillates and helps reduce residual oil output to zero.

Gulf Oil Completes Large Oxo Alcohol Unit

A multi-million-dollar oxo alcohol unit has been completed by Gulf Oil Corp. at its Philadelphia refinery.

The new unit, one of the largest of its type ever built, is designed to produce octyl, decyl and tridecyl alcohols from heptene, nonene and dodecene. This is the first major petrochemical unit to be built at Gulf's Philadelphia refinery.



Oxo alcohol unit in operation.

The olefin raw materials are first converted to aldehydes by reaction with a carbon monoxide and hydrogen synthesis gas mixture, and the aldehydes are then hydrogenated to the alcohols. The design of the oxo process is based on the operation of Gulf's Port Arthur oxo alcohol plant plus research work carried out by Gulf during the past ten years. Badger Manufacturing Co. was the engineer-constructor.

Heyden Newport Chemical Co. has placed a 24-million-pound-per-year maleic anhydride plant on stream at Fords, N. J. By the end of 1961, industry-wide capacity for maleic anhydride is expected to reach 240-250 million pounds per year.

Goliad Corp. has awarded a $1-million contract to O. L. Olsen Co., Inc., Houston, for construction of additional gas processing facilities at its Wilcox plant in Lavaca County, near Sheridan, Texas. Construction will begin immediately, with completion set for October 1961. The plant's throughput will be increased to 255 MMcfd of gas, while recovering an ethane product and increasing recovery of propane. The Wilcox facility was built in 1953.

Tidewater Oil Co. and Air Products, Inc., plan to construct and operate an oxo alcohol plant adjacent

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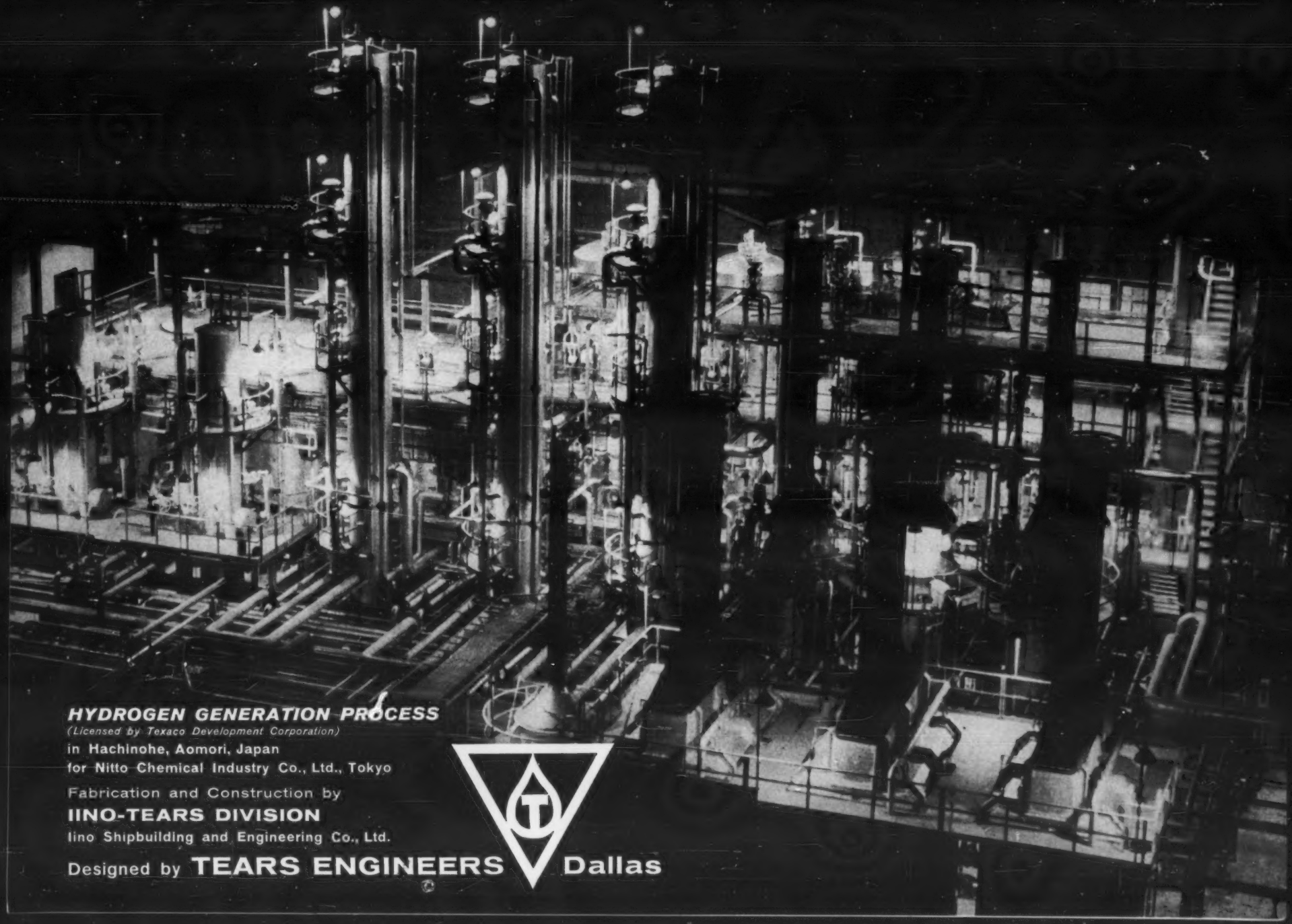
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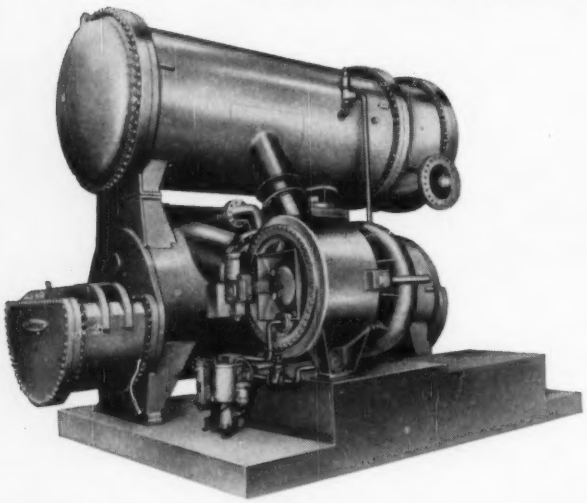

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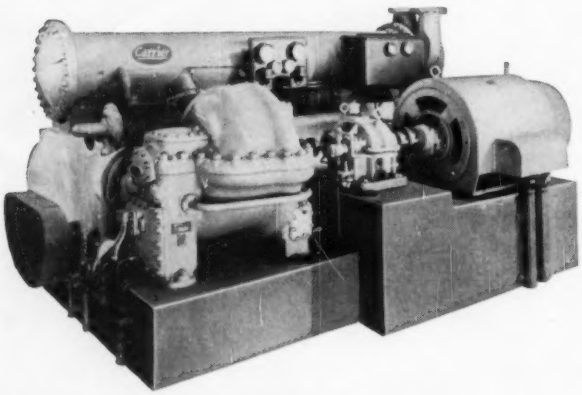

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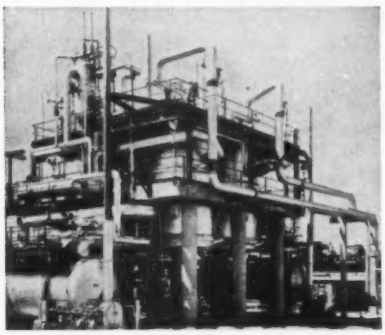
Building . . .

to Tidewater's Delaware refinery. The plant will produce iso octyl, decyl and tridecyl alcohols. The plant will be sized for eventual production of more than 60 million pounds annually. Tidewater will provide the raw materials and will operate the plant. Air Products will provide design engineering for the plant. In addition to the three alcohols produced by the facility, other new products will be manufactured after the plant is in operation.

Mobil Chemical Co., has completed a 24,000-square-foot office building at Beaumont, Texas. The aluminum-and-glass building will be the nerve center of the chemical company's manufacturing operations in the Southwest.

California Chemical Co.'s Oronite Division has completed a maleic anhydride plant at Richmond, Calif. The new facility, according to Oronite, is the first maleic anhydride plant

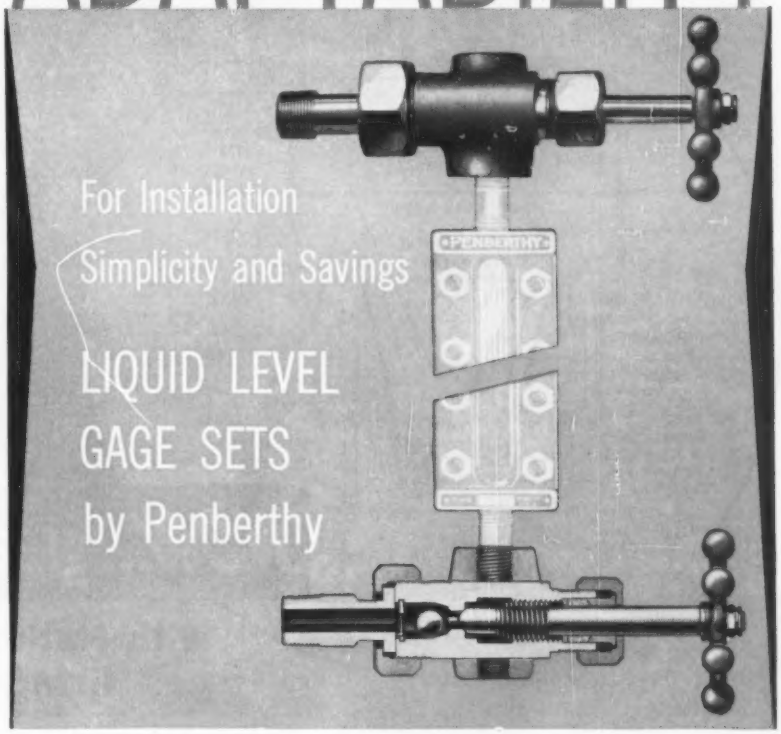


constructed in Western United States. Construction was started in March 1960. Built by Badger Manufacturing Co., the plant is able to produce 20 million pounds per year.

Nalco Chemical Co., which previously announced plans to enter alkyd lead production, has selected Freeport, Texas, for a plant site. The Fluor Corp. is handling the design and engineering work for the plant. The facility will be designed to convert about 26 million pounds per year of lead to alkyls.

Armour Agricultural Chemical Co. has started building a multi-million-dollar nitrogen plant at Cherokee,

ADAPTABILITY



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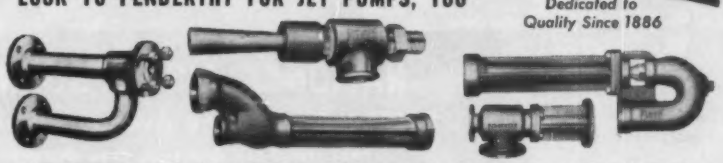

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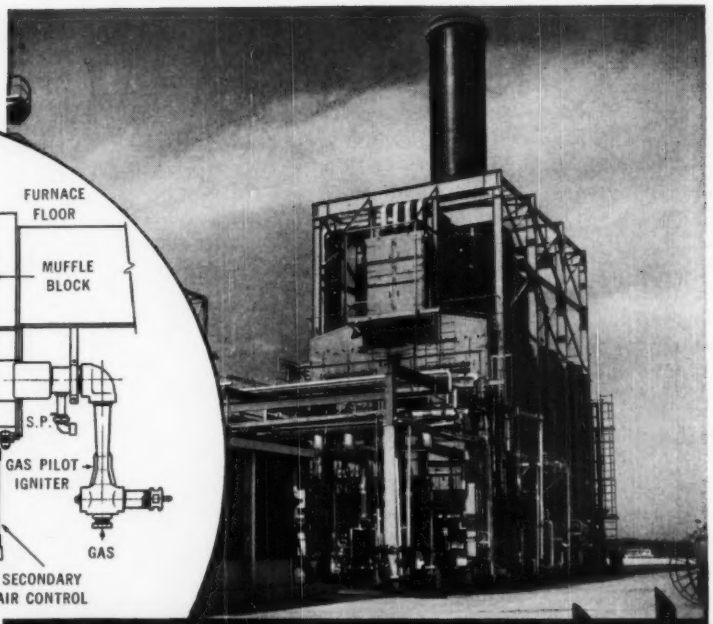

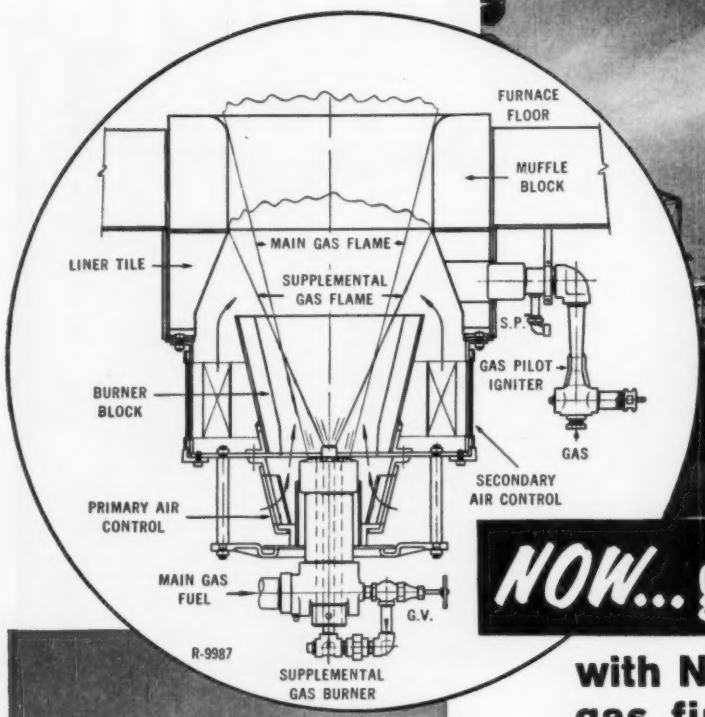

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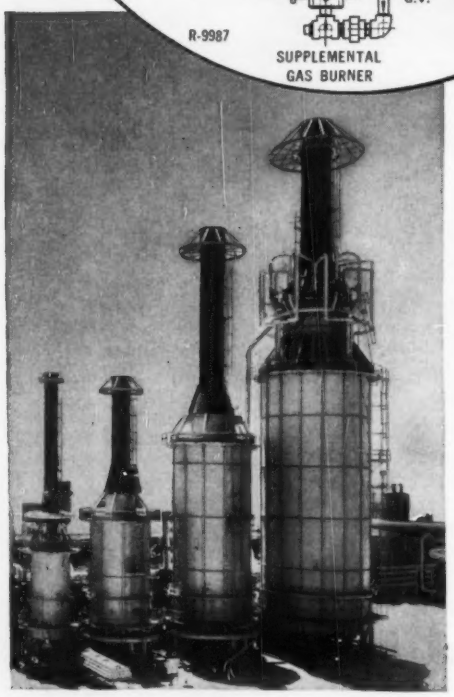

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- An increased proportion of combustion air can be induced, partially independent of stack-furnace draft.
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National Airoil C. P. gas units can be supplied with a medium pressure gas pilot for electric ignition. A sufficient range of sizes is available to handle standard capacities. A similar National Airoil design also can be furnished for *oil only*, for *combination gas and oil*, or for *forced draft*.

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Building . . .

Ala. The M. W. Kellogg Co. is handling engineering for the project. The nitrogen fertilizer complex is part of a $60-million expansion program by Armour. Completion is scheduled during the first quarter of 1962.

Collier Carbon and Chemical Co. is in the middle of an expansion program with a new 250-ton-per-day sulfuric acid plant in Los Angeles and an anhydrous phosphoric acid plant at Kellogg, Idaho. The Idaho facility is using an exclusive process developed by Union Oil Co. and Collier.

Model of ethylene oxide plant is being discussed by Houston Chemical Corp. executives. The 80-million-pound-per-year facility will be in operation at Beaumont, Texas, in the last quarter of this year by Houston Chemical. Left to right are Thomas R. Young, operations vice president; H. D. McGowan, president; and Vincent H. Shea, Sr., chairman of the firm's executive committee. In July of this year, the company expects to have a tetraethyl and tetramethyl lead gasoline additives plant on stream at Beaumont.

AviSun Corp. expects to put its 100-million-pound-per-year polypropylene plant on stream at New Castle, Del., July 15. Completion of this project will raise AviSun's total yearly capacity of polypropylene to 125 million pounds. (HYDROCARBON PROCESSING and PETROLEUM REFINER, Vol. 39, No. 10, page 208.)

W. R. Grace & Co. has definitely decided to build a 60,000-ton-per-year

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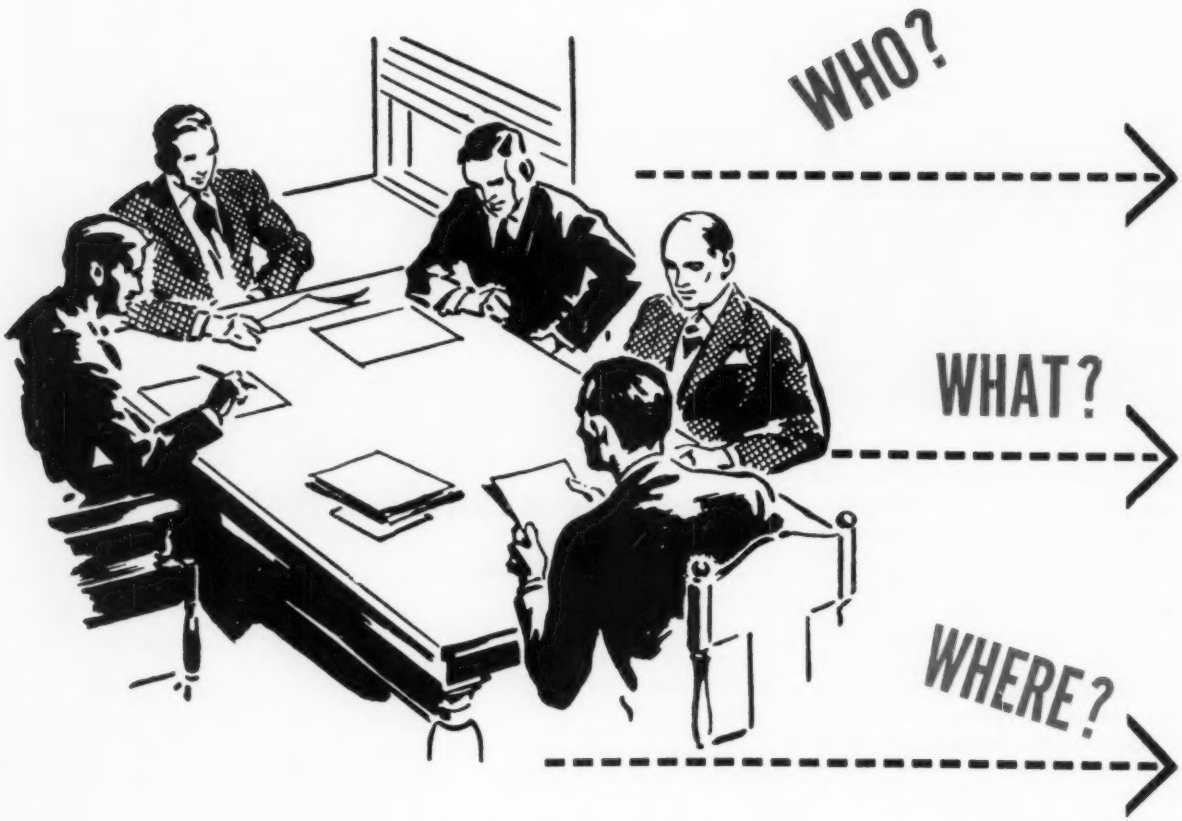

REFINERY CATALOG

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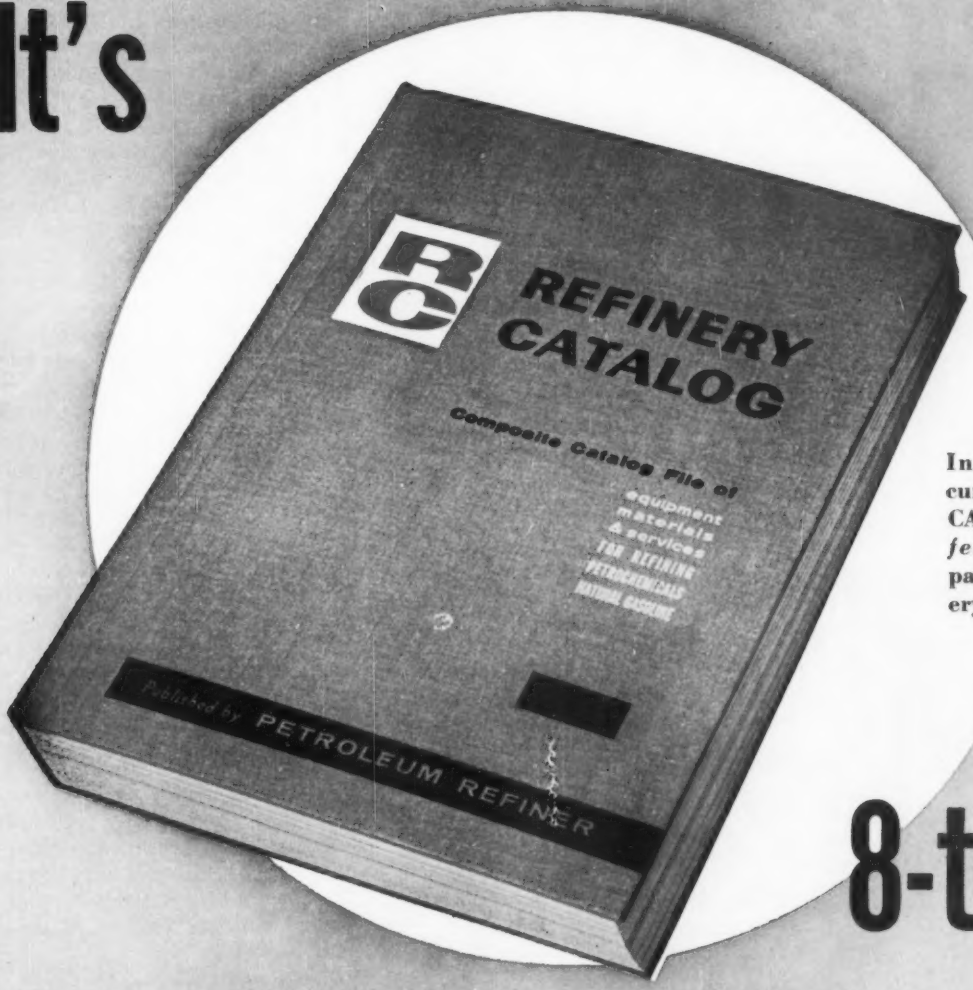

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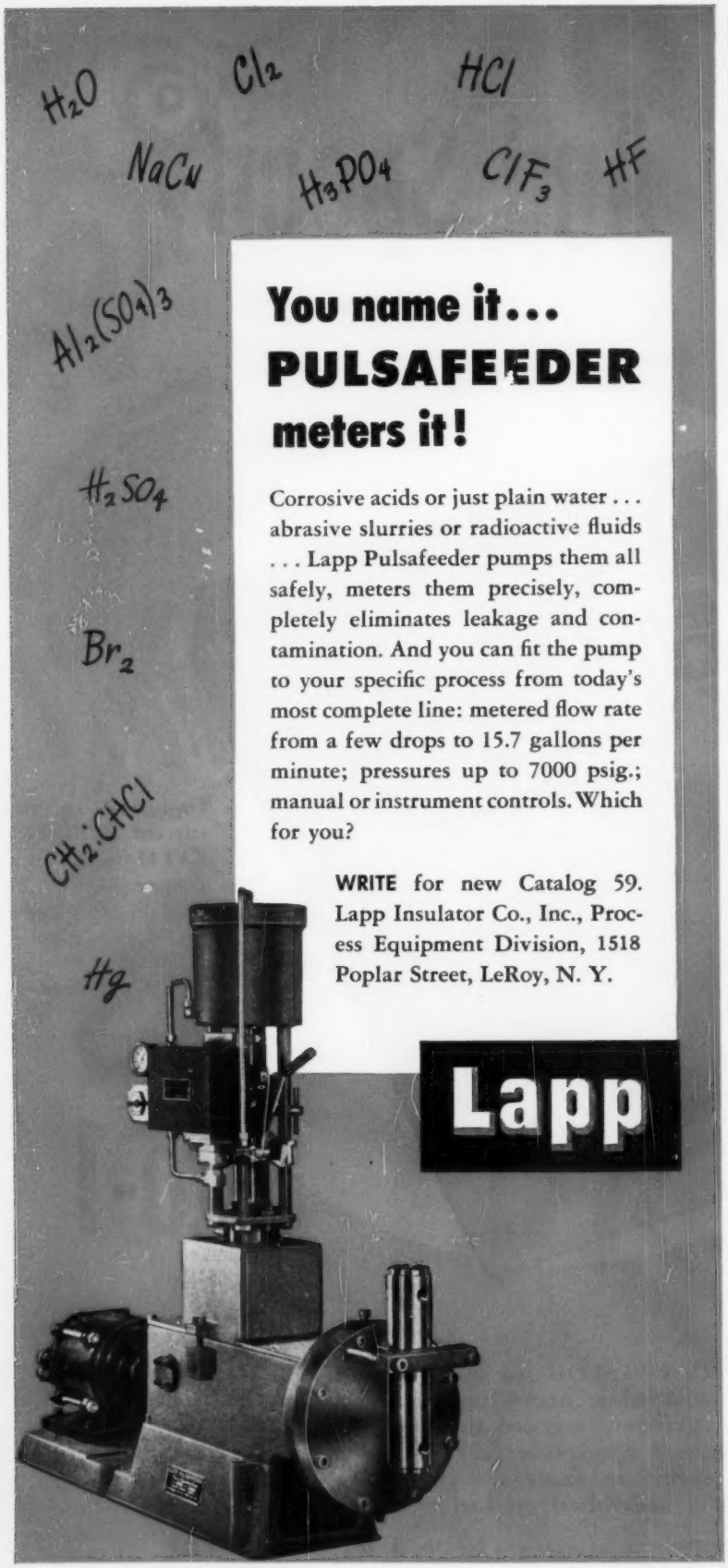
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HCl
NaCl
H_3PO_4
ClF_3
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Br_2
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Building . . .

ammonia plant at Big Spring, Texas. Foster Wheeler Corp. will handle the design and engineering for the plant, which should begin producing early next year. The facility will be operated by Cosden Petroleum Co., W. R. Grace affiliate. (HYDROCARBON PROCESSING and PETROLEUM REFINER, Vol. 40, No. 5., page 302.)

Union Texas Natural Gas Co. is thinking about constructing an ethylene plant somewhere along the Louisiana Gulf Coast to produce 200 million pounds per year. Tentative plans place the project in the Baton Rouge-New Orleans area.

The Pure Oil Co. will add a BTX unit to its Lemont, Ill., refinery. The 26-million-gallon-per-year facility will be built by Procon, Inc., subsidiary of Universal Oil Products Co. Completion is slated for November this year.

Shell Oil Co. is attempting to acquire a site in Delaware for a new refinery. Shell has made application for a tract of land 1.5 miles northeast of Smyrna, Del. Under option at present is a 3,500-acre section, which would also be the site of related petrochemical facilities.

Standard Oil Co. of California Western Operations, Inc., will construct the first major oil refinery in Alaska on a site in the Kenai Peninsula area. The new plant will have a capacity of 20,000 bpd. It will process crude oil produced by Standard from the Swanson River field.

Spencer Chemical Co. expects to strengthen its polymer picture by building a polyethylene latex plant at its Chicago (Calumet City) works. The plant will cost about $1 million. Annual capacity will be 20 million pounds.

Ashland Oil & Refining Co.'s Udex unit, under construction at the Ashland, Ky., refinery, is on schedule and expected to be in operation in August. The plant will make toluene, benzene and xylene. (HYDROCARBON PROCESSING and PETROLEUM REFINER, Vol. 40, No. 2, page 174.)

Sinclair-Koppers Chemical Co. has completed about 65 percent of its styrene plant at Pasadena, Texas. Sin-

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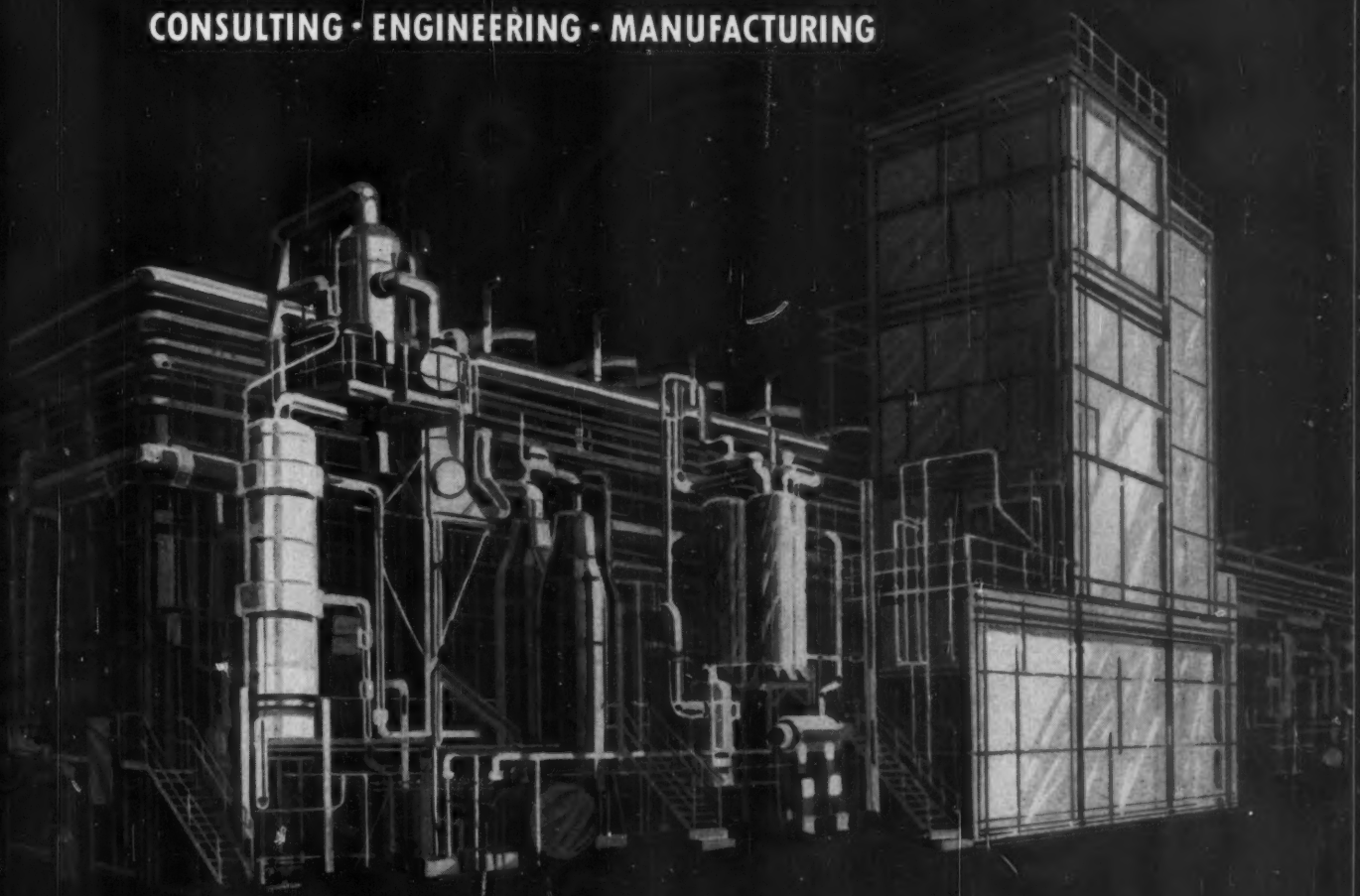

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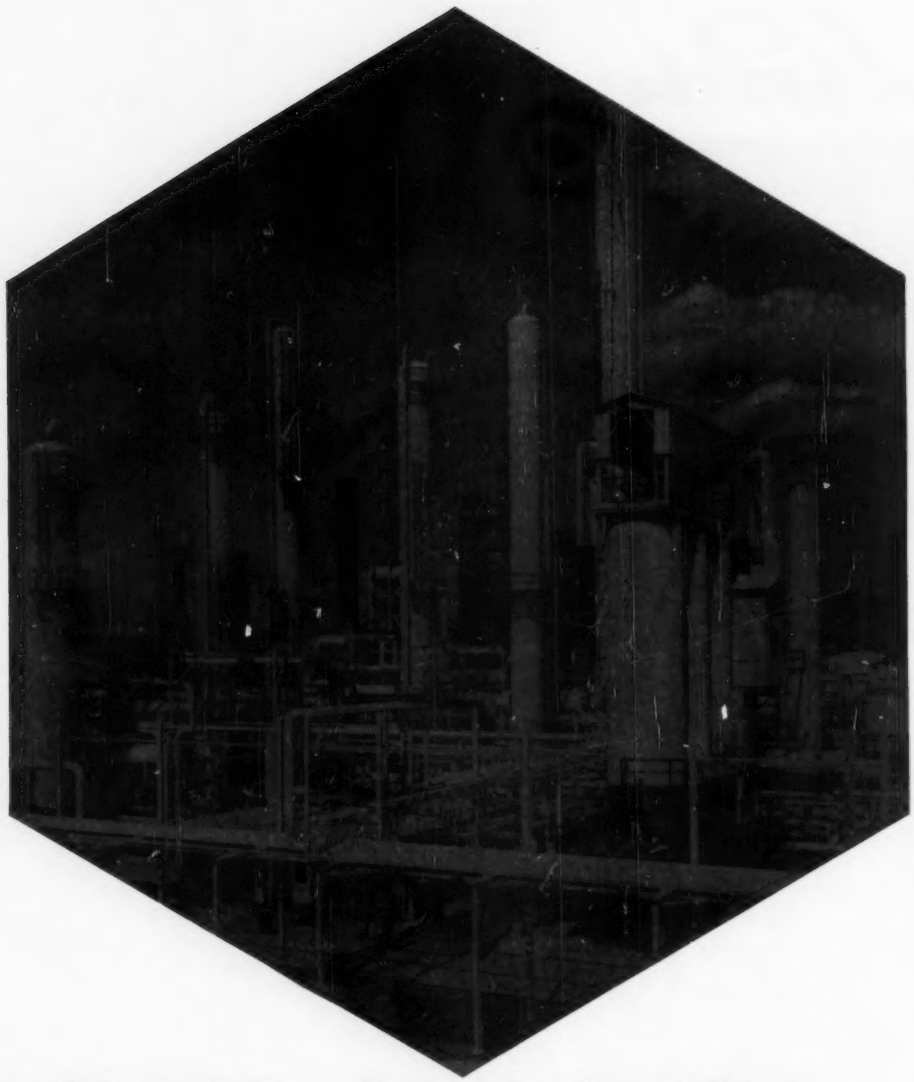

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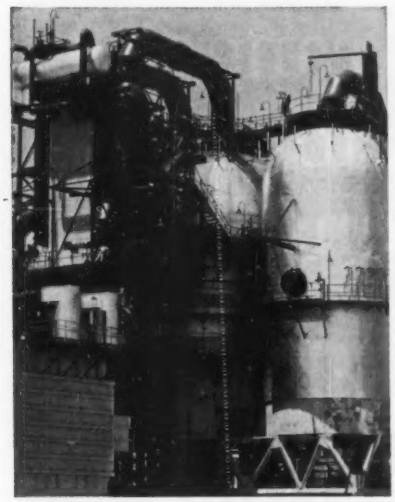
clair-Koppers is jointly owned by Sinclair Oil Corp. and Koppers Co., Inc. (HYDROCARBON PROCESSING and PETROLEUM REFINER, Vol. 40, No. 2, page 170.)



Computer will "tame" this unit.

Computer to Control 40,000-bpd Cat Cracker

A computer system is being installed at Standard Oil Co. of California's El Segundo, Calif., refinery to control a 40,000-bpd fluid catalytic cracking unit.

Expected to be completed by early summer, the installation work is not interrupting the cracker's regular production.

The process control unit will scan 75 points of information within the cracker at an initial rate of 40 points per minute. The computer's ultimate scanning capacity is 20 points per second.

Suntide Refining Co. plans to construct a paraxylene petrochemical unit at its Corpus Christi, Texas, complex. The unit will produce 15 million pounds annually when completed next January. Ralph M. Parsons Co., Los Angeles, has been awarded the construction contract.

American Gilsonite Co. plans to build facilities at its Grand Junction, Col., refinery for LPG extraction from gilsonite. To cost about $300,000, the new unit will extract 325 bpd of product, mostly propane with some butane.

British Petroleum Co. has awarded a contract to Foster Wheeler, Ltd., for the design, engineering, supply and construction of process units required for the lubricating oil project at its Kwinana refinery in Australia. Foster Wheeler will work with Constructors John Brown (Australia) Pty., Ltd. The process units include a vacuum distillation unit, a furfural extraction unit, an MEK-toluene dewaxing unit, and a Ferrofining facility. The new plant is expected to go on stream at the end of 1962 with an annual capacity of 100,000 tons of high-grade lubricants.

Wintershall A.G. will begin construction late this year on a plant to remove hydrogen sulfide. The plant will be the first to use The Fluor Corp., Ltd.'s, solvent process for bulk removal of H_2S. To cost $2 million, the facility will also simultaneously remove carbon dioxide. Process design for the units will be supplied by Fluor. The company's Dutch subsidiary, Fluor-Schuytvlot N.V., will handle engine ring, materials procurement and construction. The facility will be built at a recently developed natural gas field near Dueste, a small town about 30 miles southwest of Bremen, West Germany. Completion is set for the fall of 1962. The treating units will purify 28 MMcfd at 1,000 psig. By-product H_2S will be fed to the sulfur recovery unit.

Texaco Trinidad, Inc., has placed a second UOP Platforming unit on stream at its West Indies refinery, Pointe-a-Pierre, Trinidad. The 15,000-bpd process unit is producing a motor fuel blending stock with an unleaded rating of 93 research octane number. Charge stock is mainly light straight run naphtha derived from Safaniya crude. The unit was designed and licensed by Universal Oil Products Co.

Svenska Esso A.B., an affiliate of Standard Oil Co. (New Jersey), has awarded The Fluor Corp. Ltd., a contract worth over $15 million to handle the engineering, materials procurement and construction of a steam cracking plant. The installation will be the heart of a Svenska petrochemical project located at Stenungsund, Sweden. Esso Research & Engineering Co. will provide overall design of the unit. Engineering and procurement will be carried out by Fluor's English

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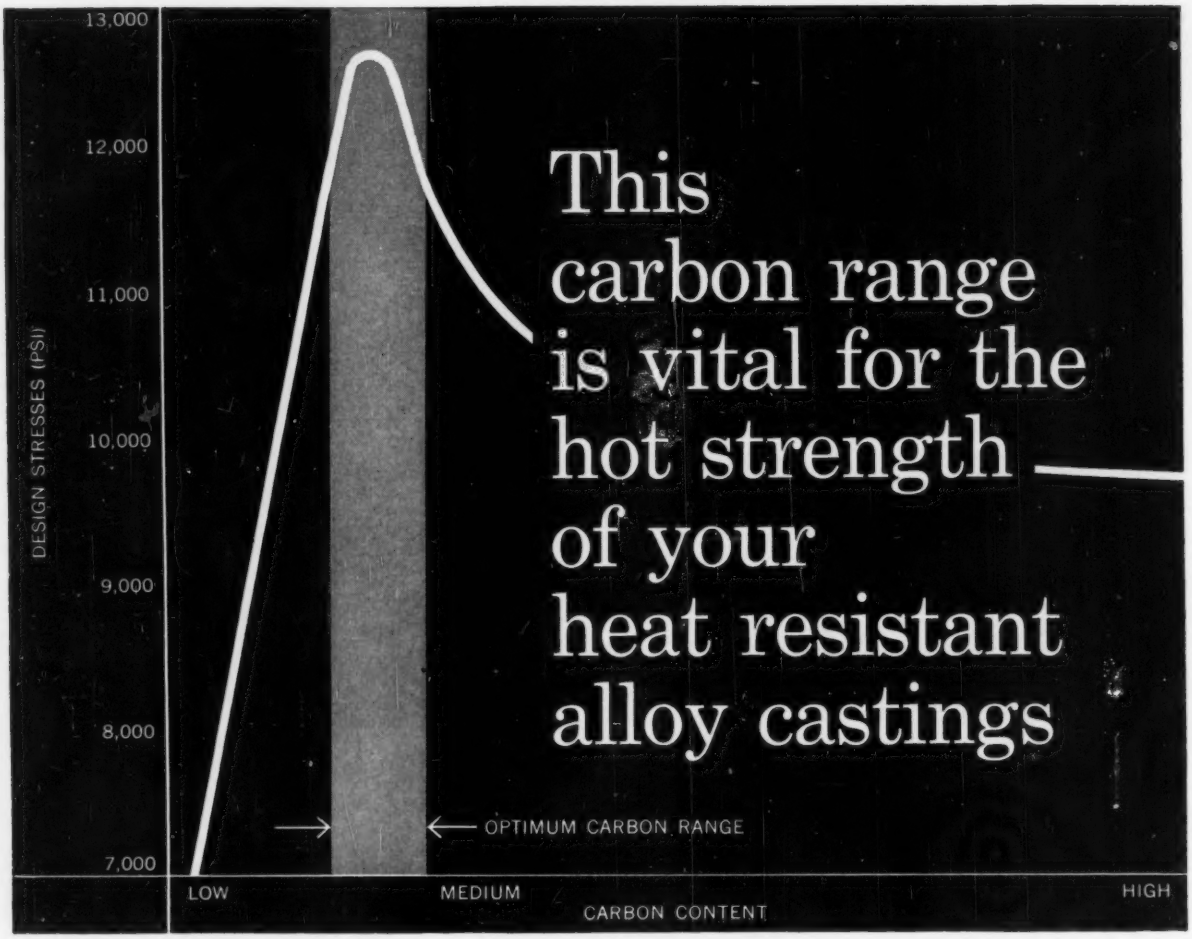

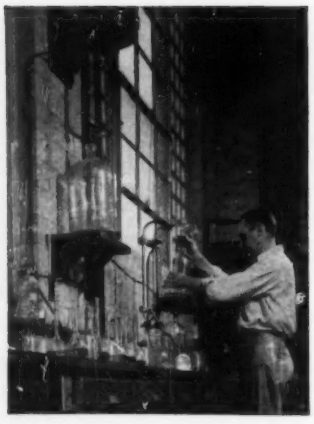

Every foundry heat is analyzed to insure specified alloy composition

This graph illustrates the effect of carbon content on the hot strength of a heat resistant alloy. It outlines an optimum carbon range. The graph shows how a carbon content outside the optimum range would seriously lower the hot strength decreasing the service life of the casting. The optimum carbon range is 0.10 percent.

Controlling carbon content to within one-tenth of one percent is difficult, but Electro-Alloys does it. Compositional control of castings at Electro-Alloys is exact and painstaking. Without this care you cannot expect maximum efficiency and long service life.

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ELECTRO-ALLOYS DIVISION • Elyria, Ohio

Building . . .

subsidiary, Fluor Engineering & Construction Co., Ltd. Construction will begin late this summer, with completion scheduled for spring 1963.

Phillips Petroleum Co., Bartlesville, Okla., and Bridgestone Tire Co., Ltd., Tokyo, Japan, have signed a cis-polybutadiene synthetic rubber licensing agreement under which Bridgestone will build a 10,000 ton-per-year plant in Japan using the Phillips process and technical knowledge. As licensor, Phillips will furnish process design to Bridgestone and serve as technical advisor on engineering, construction and initial operation of the plant.

Petroleos de Galicia, a company backed mostly by French capital, has made a proposal for the construction of a refinery at Vigo, in northwestern Spain, to the Spanish government. This is the second proposal made by the firm. The project would consist of a 24,000-bpd plant built for approximately $15 million.

Correction

In the April 1961 HYDROCARBON PROCESSING & PETROLEUM REFINER, Page 200, the item concerning Aruba Chemical Industries N. V., mistakenly placed the company's $96-million fertilizer complex at Aruba, Venezuela. This should have been Aruba, Netherlands West Indies.

Esso A. G. will soon begin construction on a 72,000-bpd refinery at Karlsruhe, West Germany. The plant is expected to go on stream by January 1963. Crude will reach the refinery through a 475-mile pipe line from Lavera near Marseille, France.

Ente Nazionale Idrocarburi is eying the possibility of building a refinery in Ceylon. A negotiating team is working for a "50-50" arrangement with the Ceylon government.

ENSA, a French company, will build a refinery in the Dominican Republic. The plant will run Sahara crude supplied by Regie Autonome des Petroles, SN-Repal and SNPA. ENSA is an affiliate of the French construction company, Schneider.

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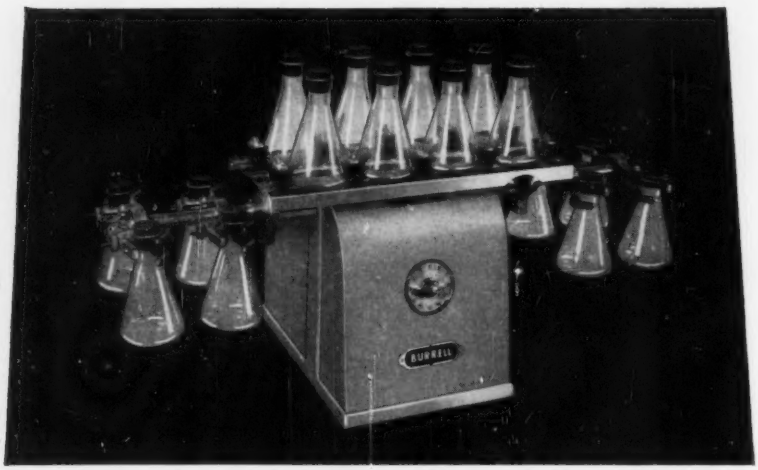

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Building . . .

Union Carbide of India, Ltd., has completed a $9-million polyethylene plant at Trombay Island near Bombay, India. Capacity of the facility is 15 million pounds per year of resins and organic chemicals.

Standard-Vacuum Oil Co. has completed a refinery on Bataan Peninsula overlooking Manila Harbor. The 24,000-bpd fuel products plant brings Stanvac's refining investments in Asia, South Africa and Australia to $275 million.

Home Oil Co., Ltd., is expanding its gas processing plant at Carstairs, Alta., from 70,000 Mcfd to 200,000 Mcfd. Cost of the expansion, to be completed in November, is about $4.3 million. Fluor Corp. of Canada will be contractor on the job.

Correction

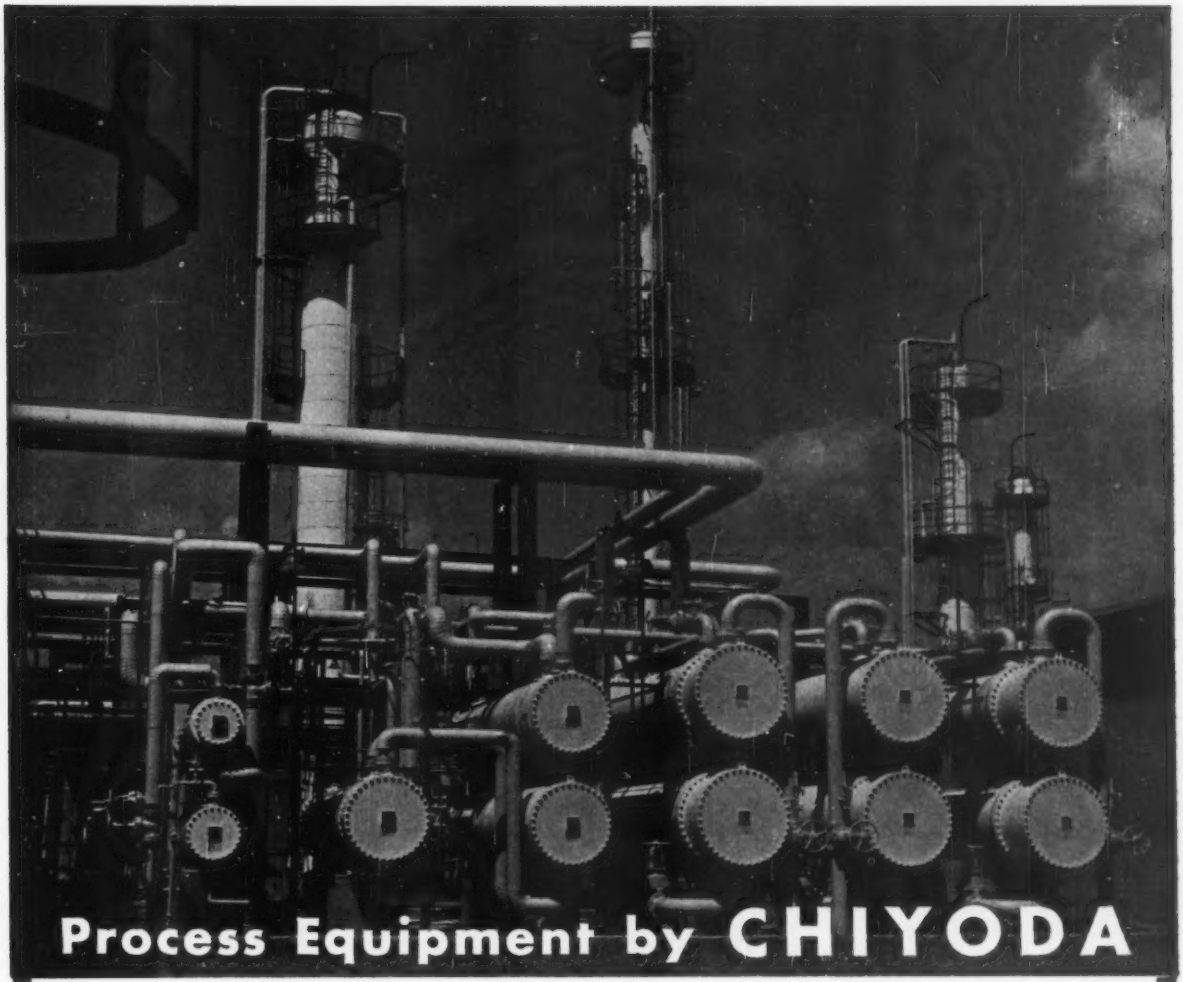
The item in HYDROCARBON PROCESSING & PETROLEUM REFINER, March 1961, Page 246, involving a petrochemical venture in Israel, should not have included Sonneborn Chemical Co. and Witco Chemical Co. as participants. Instead, Sonneborn Associates Petroleum Corp., parent company of Sonol, an Israeli firm, is one of the American companies concerned with the petrochemical complex to be built at Haifa, Israel.

Mobil Oil Co. has completed a plant at Santos, Brazil, for the production of high-quality automotive and industrial greases.

Esso Sirte, Inc., an affiliate of Standard Oil Co. (New Jersey), will build a refinery at Marsa El Brega, Libya. One of Jersey's Algerian affiliates will participate in another plant to be built in Algiers.

Iraq expects to have its first chemical fertilizer plant on stream by 1965, reports the Iraqi Ministry of Industry. Projected production is for 116,000 tons per year of ammonium sulfate, 56,000 tons of ammonium nitrate and 20,000 tons of sulfuric acid.

Badger N.V., an affiliate of Badger Manufacturing Co., has completed a contract involving engineering, procurement and construction supervision of crude distillation facilities for Albatros, in Belgium. The plant capacity has been increased to 700,000 tons per year of Algerian crude.



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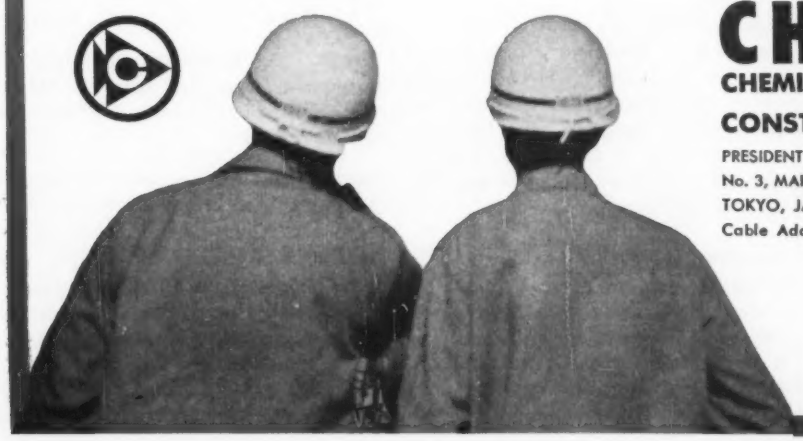

For more data on advertised products, use cards, last page.

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Gray Bimetallic pipe provides all the fabrication and strength advantages of carbon steel with the corrosion resistance of the best alloy materials, and at a fraction of the cost of a solid alloy system.

In the Gray process, a seamless lining is hydraulically expanded into the base pipe, forming a tight bond due to differential contraction of the materials. For all practical purposes the bond is permanent. Bimetallic pipe can then be fabricated almost as easily as carbon steel. It can be butt welded, flanged and bent without damage to the lining or the bond.

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This wide range of materials available make Bimetallic pipe ideal for all applications where corrosion is a factor. It is well suited where product contamination or catalyst poisoning are problems.

Gray Bimetallic pipe provides the corrosion resistance of special alloys at only a small cost more than that of regular carbon steel piping. For complete details, mail the coupon below today!

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Men in HPI...

Alden

Sweeney

R. C. Alden (retired), formerly research director Phillips Petroleum Co., Bartlesville, Okla., and W. J. Sweeney, vice president, Esso Research and Engineering Co., Linden, N. J., were presented the API Certificate of Appreciation at the 26th midyear meeting of the API Division of Refining in Houston last month.

J. K. Jamieson, president of International Petroleum Co., Ltd., has been elected a vice president and a member of the board of directors, Humble Oil & Refining Co. Jamieson, presently living in Miami, Fla., will move to Humble's Houston headquarters.

Walter S. Hallanan has been elected chairman of Plymouth Oil Co. He has been president of the company since its organization in 1923. Succeeding Hallanan as president and chief executive officer is **Paul G. Benedum,** director since 1943 and vice president for the last 10 years. Benedum is also president of Hiawatha Oil & Gas and Penn-Ohio Gas.

Edward L. Steiniger, president of Sinclair Oil Corp., has been named chief executive officer of the company. **P. C. Spencer,** who has been re-elected for a three-year term to the board of directors, will continue as board chairman.

Stephen L. Wythe has joined Enjay Chemical Co. as product manager, Paramins Division. Wythe replaces **Warren C. Wilson,** who has accepted a post with Svenska Esso A. B. as head of that company's newly formed Petrochemicals Department.

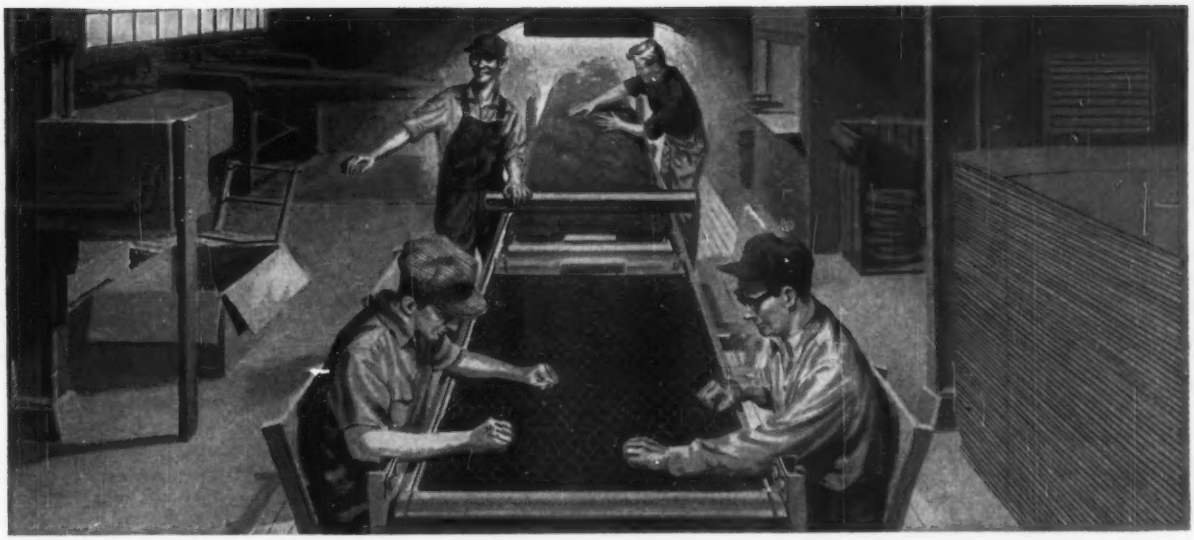
P. L. Vander Jagt, Salt Lake City, has been named managing director of Amoco Italia, S.p.A., Italian refining and marketing affiliate of Standard Oil Co. (Indiana).

A. C. Brodie has been promoted to assistant to the president, Badger Manufacturing Co., Cambridge, Mass. Brodie has B.S.M.E., B.S.E.E. and M.S. E.E. degrees from the Massachusetts Institute of Technology. Prior to joining Badger Manufacturing in 1957, he was vice president of Feedback Controls, an electronic concern.

Brodie

Ernest D. Brockett, president of Gulf Oil Corp., has been elected to the board of directors, Westinghouse Electric Corp.

James M. Jans, formerly assistant chief engineer, has been named chief engineer, Allied Chemical Co.'s General Chemical Division. Other appointments in the division include: **Robert G. Bierbower,** manager of engineering administration; **John L. Ciba,** manager of design engineering; **Charles W. Gaylord,** manager of process engineering; and **James**



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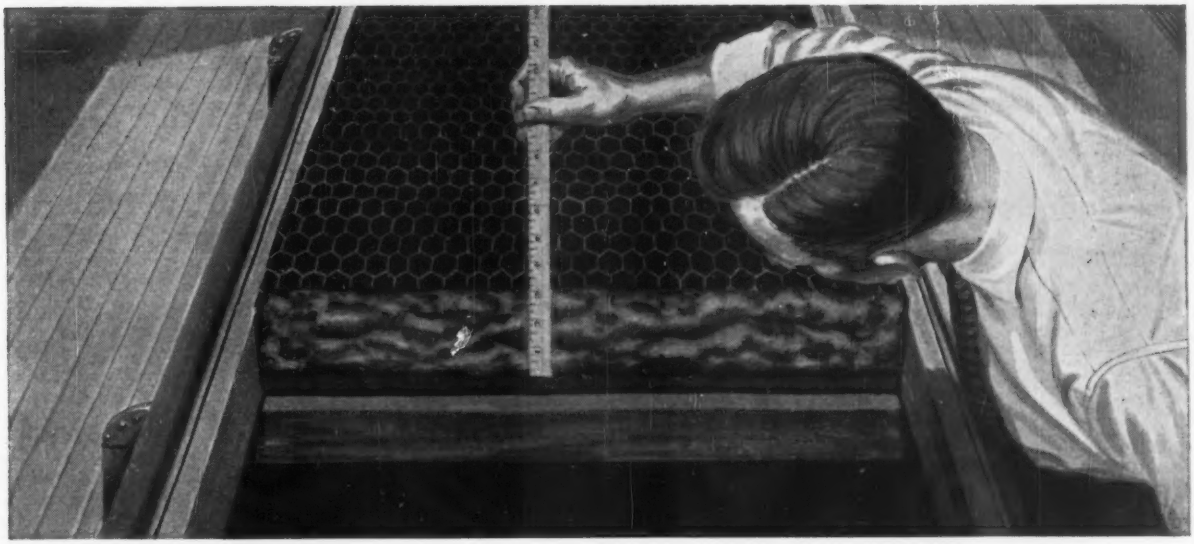

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Storage Tank Vent Drier GUARDS Liquids against Moisture..

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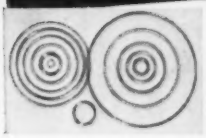

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Men . . .

Jaffe, manager of process engineering. All of the men have been with Allied Chemical for over 10 years.

William J. Sheridan has been named manager of Humble Oil & Refining Co.'s

Sheridan

Coates

Winkel

Bayway refinery, Linden, N. J. He succeeds **G. Ross Murrell,** manager at Bayway since 1957, who has accepted a post with Standard Vacuum Oil Co. Sheridan has been manager of Humble's Everett, Mass., refinery since 1959. His successor at Everett is **John J. Coates,** who has been manager of Humble's Pittsburgh, Pa., grease manufacturing plant since 1958. **Robert B. Winkel** will replace Coates as manager of the Pittsburgh plant. Winkel has been operations superintendent at Humble's Bayonne, N. J., refinery since 1959.

Dr. James L. Wyatt has been named vice president for program development, Armour Research Foundation of Illinois Institute of Technology. For four years prior to joining ARF, Wyatt was an associate in the New York offices of Booz-Allen and Hamilton, management consultants. He specialized in research and development management, systems and procedures, and new product planning programs.

Primo L. Pinotti has joined the Oronite Division, California Chemical Co., a subsidiary of Standard Oil Co. of California, as product specialist, petroleum chemicals. Prior to joining Oronite, Pinotti was senior product engineer for Standard Oil's Product Engineering Department. He was with California Research Corp. from 1943 to 1953 engaged in fuel and lubricant research activities.

Rex D. Struble has been appointed manager, Methods and Standards Department, The Atlantic Refining Co. He replaces **Thomas E. Kelly,** who retired recently after 26 years with the firm. Struble joined Atlantic in January 1960.

Dr. William E. Bradley, director of research for Union Oil Co. of California, has been elected a vice president. Dr. Bradley will continue to direct research. He joined Union Oil in 1931 as an associate chemist in the Research Department. He has been progressively assistant to the patent counsel, supervisor of petroleum product research, assistant to the vice president of research, manager of refining research, and director of research.

Joe A. Moss has been named secretary of Cosden Petroleum Corp. Moss, who will continue as assistant general counsel, succeeds **Nelson Phillips, Jr.,** who will remain as a director and vice president, and as general counsel.

Dr. Neil V. Hakala has been named deputy to the vice president for petroleum products, medical, basic and analytical research, Esso Research and Engineering Co. Dr. Hakala was previously director, Products Research Division. **Robert L. Weeks,** formerly an assistant director, has been named acting director of that division.

Kenneth A. Scott has been appointed manager of intelligence, Commercial Development Division, Sun Oil Co.'s Research and Engineering Department. Scott will be responsible for advance information and evaluation of developments in science and technology from government and industrial sources.

Joseph L. Stratman has been appointed manager of distribution and exchanges, Texas City Refining, Inc. Stratman graduated from the University of Louisville in 1947 with a chemical engineering degree.

N. Harvey Collisson has been elected a director of Olin Mathieson Chemical Corp. Collisson is senior vice president and chairman of the president's staff committee. Prior to this appointment in August 1960, he was vice president and general manager of the Metals Division, and before that served as corporate vice president for production and engineering. He joined Olin in 1950 as general manager of the Cellophane Division.

Collisson

Marling J. Ankeny will continue as director of U.S. Bureau of Mines, according to Interior Secretary Stewart L. Udall. Ankeny, an employe of the Interior Department for 28 years, was appointed bureau director in 1956.

Dr. Robert W. Van Houten, president of Newark College of Engineering and director of Newark Technical School, has been elected president, American

INDUSTRY'S MAGIC WHEEL

This is an open radial impeller . . . the heart of the Elliott H-line centrifugal compressor. The H-line compressor will ■ do more work ■ handle more gases ■ serve more applications than any conventional design. It permits dramatic reduction in compressor size and weight, facilitates Iso-cooling, and extends the advantages of **centrifugal** compressors into entirely new fields of application.

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EXAMPLE:
a process gas compressor

This is a single-stage H-line compressor, with open radial impeller. Casing diameter, 34 inches; total weight, 1020 pounds, capacity 3000 icfm. A **conventional** centrifugal to do the same job would be a 3-stage unit weighing about 9000 pounds.

Because corrosive gases will be handled, outer casing and all internal parts are made of stainless steels. This is economically feasible with Elliott H-line compressors due to their extremely small size and resulting light weight.

The one-piece, radial-bladed impeller has no cover or shroud member to create bending and hoop stresses.

Elliott H-line compressors include a wide variety of sizes and capacities, from 300 to 40,000 icfm.

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PI-1

Men . . .

Society for Engineering Education. He will serve for one year beginning July 1. **Dr. George A. Marston,** dean of engineering, University of Massachusetts, and **Dr. Curtis L. Wilson,** dean of Missouri School of Mines and Metallurgy, have been named vice presidents in the society.

Dr. Albert W. Musgrave, computer designer and now a Mobil Oil Co. geophysicist, has been named the 1961 recipient of the Colorado School of Mines van Diest Gold Medal. The van Diest Gold Medal was established in 1950 by Dr. Edmond C. van Diest, a Mines graduate of 1886. The coveted award recognizes Mines alumni who perform outstanding achievements within five to 15 years following graduation.

Dr. John H. Long has been elected a vice president and member of the executive committee, Hercules Powder Co. Dr. Long has been a member of the company's board of directors since December 1958. He joined Hercules Powder in June 1933 as a chemist at the company's research center, near Wilmington, Del.

Robert D. Bowser has joined the petroleum consulting firm of D. R. McCord and Associates, Inc., Dallas, Texas, where he will head the Process and Engineering Division. Bowser was previously assistant superintendent of gas compression and gasoline plants and head of the special studies and design group for Creole Petroleum Corp. in Venezula. He has also been with Tellepsen Construction Co. and Mene Grande in various process and design engineering posts.

Bowser

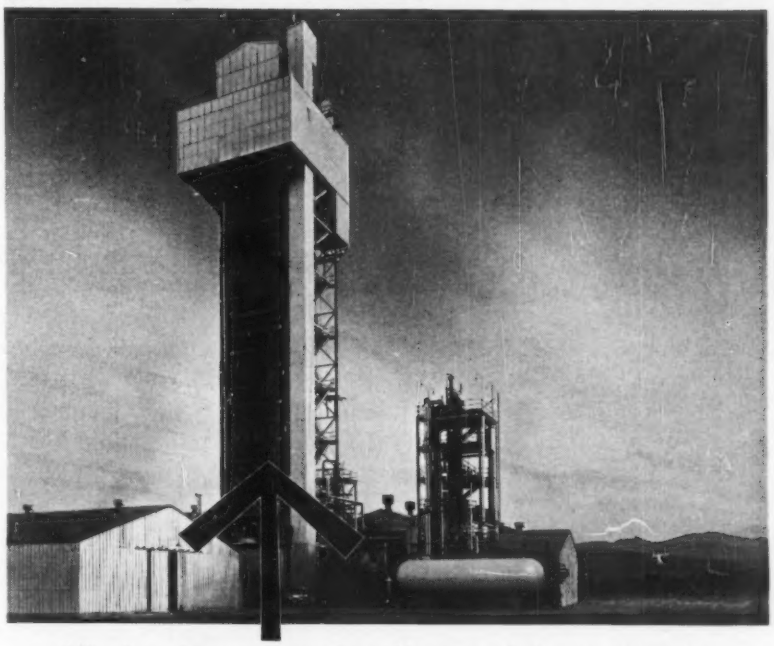
Dr. C. S. Overmiller has been appointed manager of economics, Headquarters Economics and Planning Department, Humble Oil & Refining Co., Houston. Dr. Overmiller, who has been assistant treasurer for the company, will study both general and petroleum economics on a domestic scale.

E. O. N. Williams, Richmond, Va., has been elected president, Liquefied Petroleum Gas Association. Williams is president of Bottled Gas Corp. of Virginia, Richmond, an LPG marketing firm. He succeeds **R. J. Munzer,** Long Beach, Calif., who had been LPGA president for the past year.

Dr. Arthur E. Humphrey, associate professor of chemical engineering at the University of Pennsylvania, has been appointed director, School of Chemical Engineering. Dr. Humphrey will succeed **Dr. Melvin C. Molstad,** who has been

from ALCOA

good designs made better with aluminum



All-aluminum construction resists corrosion, weatherproofs thermal insulation in Spencer Chemical prilling tower

This 180-ft, all-aluminum, urea prilling tower, operated by Spencer Chemical Co., Henderson, Ky., was built by Mississippi Valley Structural Steel Co., St. Louis, Mo. To ensure uninterrupted, corrosion-free service, plant designers used Alcoa® Aluminum throughout—frame, walls, bolts, piping, fittings, connections and fasteners. Aluminum sheathing weatherproofs thermal insulation on tower, heat exchangers and piping. Please send the coupon for more information about Alcoa Aluminum's unique advantages.

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NEW SLANTS ON HEAT PROCESSING FROM SELAS

what ethylene producers are doing about increasing capacity

The domestic demand for ethylene, largest-volume olefinic raw material produced by the petrochemical industry, continues to grow at a substantial rate. Over a four-year period (1955-'59), production capacity for ethylene skyrocketed from a little over three billion to a 5.6 billion pounds per year. And the plateau for this fast growth rate is nowhere in sight. Conservative estimates indicate that by 1965, ethylene capacity in the U.S. will have reached a rewarding 7.1 billion lbs./year.

Giving life to this tremendous growth in production capacity is the cracking furnace. In many petrochemical plants throughout the United States, the cracking furnaces were designed and built by Selas.

The record shows that Selas supplied 47.5% of the total ethylene production capacity, from all sources, in the 1955-'59 period. This represented 79% of the furnaces designed and constructed by firms other than the petrochemical companies' own engineering staffs. The 31 Selas GRADIATION® furnaces installed from '55 to '59 corresponded to a total ethylene cracking capacity of 1.2 billion pounds. In 1960, Selas sold or installed cracking furnaces representing additional ethylene production capacity of 0.96 billion pounds or 80% as much capacity as Selas sold and installed in the previous four years.

The acceptance of GRADIATION furnaces for ethylene production is exemplified by repeat orders. In the past eight years, one leading ethylene producer has —on nine different occasions—purchased a total of 17 Selas GRADIATION cracking furnaces. Two other petrochemical plants have each installed 11 furnaces. Each made four separate purchases to reach their present production capacity.

As the human heart adjusts to the varying demands of the body, so are Selas GRADIATION furnaces adjusted to changes in ethylene production dictated by competitive pressures. The Selas furnace, for example, permits cracking of ethane, propane, butane or naphthas by simple, easily-made adjustments in the patented radiant heating pattern. This flexibility—combined with the uniformity of heating and controllability of Selas furnaces—allows ethylene producers to obtain optimum yields from varying feed stocks, and to balance their production economically against changing marketing situations.

A Selas engineer is prepared to discuss your processing needs with you. For this service—without cost or obligation to you—or for a copy of Bulletin 1043—"GRADIATION Heating for Petroleum and Chemical Processing," write to the Fluid Processing Division.

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Men . . .

in charge of the chemical engineering program since 1939, and director of the School of Chemical Engineering since 1952.

Dr. Everett C. Hughes and **Robert W. Haigh** have been elected vice presidents, The Standard Oil Co. (Ohio). Dr. Hughes, who joined Sohio in 1930 as

Haigh

Hughes

head chemist at the research laboratory, is vice president for research. He became chief, Chemical and Physical Research Division in 1944 and since 1959 has been manager, Research Department. Haigh, who is vice president for planning, recently became Sohio's director of planning after teaching at Harvard University.

Dr. Alvin I. Kosak, an associate professor of chemistry at New York University, has been appointed chairman, Chemistry Department the university's Washington Square College of Arts and Science.

Eugene Runes has joined the Research and Development Department, American Oil Co., Whiting, Ind., as senior project engineer. He will study unusual engineering problems that arise in petroleum refining. He was formerly with the Armour Research Foundation.

Dr. Ray P. Dinsmore has retired as vice president of The Goodyear Tire & Rubber Co. His successor as research and development chief has not yet been named. He has been a vice president since 1943 and a member of the Goodyear board of directors since April 1960. Dr. Dinsmore first took over direction of Goodyear's research activities in 1921.

Dinsmore

Claude K. Rice, analytical and testing section coordinator for Gulf Oil Corp.'s Philadelphia refinery technology laboratory, has received the eighth Max Hecht Award presented by the American Society for Testing Materials' Committee

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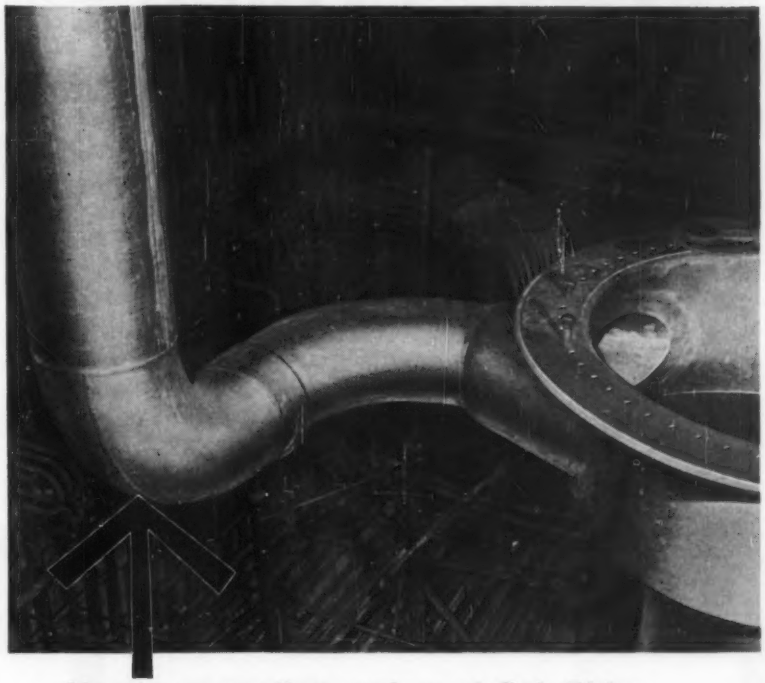

Aluminum cooling system at Oak Ridge includes Tube-Turn fittings

At Oak Ridge National Laboratory, a cooling system utilizing aluminum forces more than 12,000 gal of water per minute through the research reactor. Welding fittings up to 24 in., thought to be the world's largest of aluminum, were made with Alcoa® Aluminum by Tube Turns Division of Chemetron Corporation, Louisville, Ky. Aluminum was selected to maintain purity of the demineralized water. Other advantages: aluminum's low cost, corrosion resistance and superior heat-transfer ability. To take advantage of Alcoa's 35 years of heat exchanger experience, please send the coupon.

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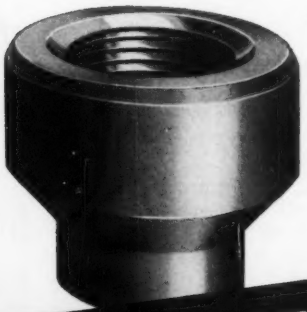
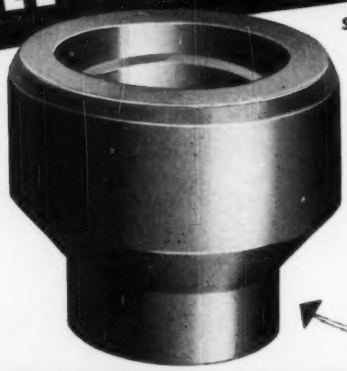


THREADED TYPE

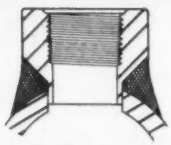


SOCKET WELD TYPE

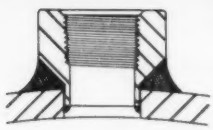
*with Exclusive Vogt "WELD RING"

The Vogt Weld Couplet is an easy-to-install fitting for branch connections from pipe, vessels or tanks. It replaces more-difficult-to-install welding bosses, couplings and the type of fittings requiring trimming or matching to fit contour of vessel or pipe.

How's How the Exclusive VOGT "WELD RING" Saves Time and Money!



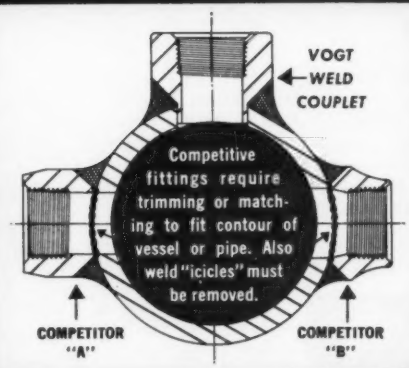
Small Diameter Pipe



Large Diameter Vessel

Vogt Weld Couplets adapt to any pipe or vessel curvature by simply adjusting the height position of the couplet when welding. This characteristic means easy installation, positive positioning and alignment, a stronger weld without distortion, and no inside "icicles" of welding material.

Couplets are available in carbon steel, conforming to A.S.T.M. specifications. Other materials can be supplied on special order.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Competitive fittings require trimming or matching to fit contour of vessel or pipe. Also weld "icicles" must be removed.
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Men . . .

D-19 on Industrial Water. This award is given each year to a member of the ASTM Committee D-19 who has performed some outstanding work in the committee or in the fields of industrial water.

Thomas C. Jones has been elected chairman of the board, Nalco Chemical Co. He continues as the firm's chief executive officer. **Dr. David G. Braithwaite** has been named president, succeeding

Jones

Braithwaite

Jones. Jones has been a company director since 1953 and a member of the executive committee since 1954. Braithwaite was elected executive vice president in 1959, and has been a director since 1957.

Dr. Carlo Giraudi has been elected vice president in charge of research, development and engineering, Witco Chemical Co., Inc. He was vice president and technical director of Ultra Chemical Works, Inc., a Witco subsidiary, which he joined in 1949. Dr. Giraudi's responsibilities extend to all Witco divisions and subsidiaries, including Sonneborn Chemical and Refining Corp. He received his Ph.D. degree from the Polytechnic Institute of Milan, Italy.

Giraudi

E. J. Karle has been elected a vice president of California Oil Co., Eastern Division. He succeeds **C. E. Allen,** who has retired. Karle has been assigned to Caloil since 1949, and is currently manager of operations, Refining Department. He served as an engineer for Standard Oil Co. of California, at its Richmond, Calif., refinery prior to his transfer to the East Coast. Karle, who will be general manager of the company's Refining De-

Karle

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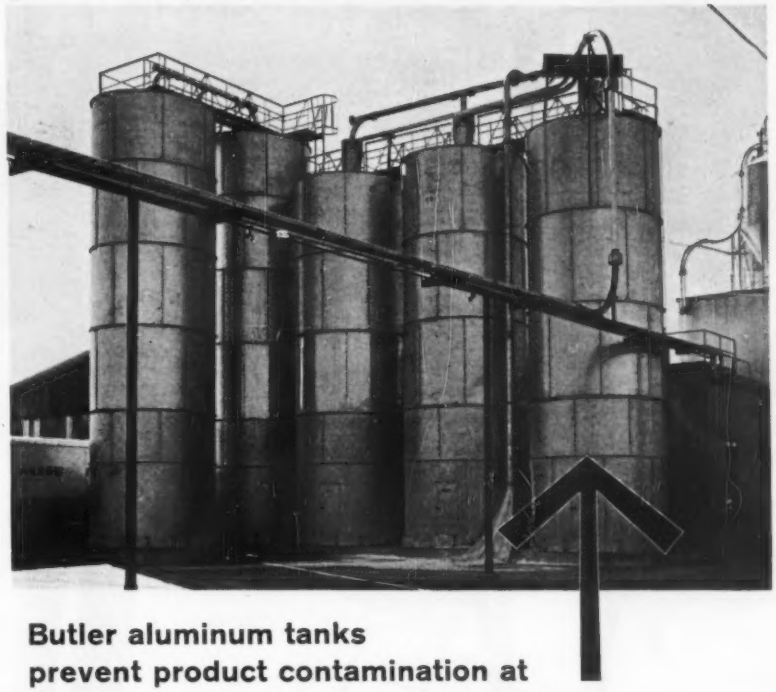
good designs made better with aluminum



Butler aluminum tanks prevent product contamination at Dow Chemical's Saginaw Bay Division

This aluminum storage installation maintains product purity for the polychemicals department of Dow Chemical Co., Bay City, Mich. Used for polystyrene, polypropylene or polyvinyl chloride, these bolted tanks were fabricated of ALCOA® Aluminum by the Bulk Storage Division of Butler Manufacturing Co., Kansas City, Mo. Many sensitive chemicals and oils are handled today in aluminum to avoid product degradation or decomposition. Moreover, low initial cost and no maintenance make aluminum an economical investment. We'd like to send you more information. Please mail the coupon.

ALCOA ALUMINUM
ALUMINUM COMPANY OF AMERICA

Aluminum Company of America, 827-FF Alcoa Building, Pittsburgh 19, Pa.

Please send me the following literature covering Alcoa Aluminum for tubular products and other uses in the process industries.

☐ 68-10460 *Process Industries Applications of Alcoa Aluminum*
☐ 42-20849 *Resistance of Aluminum Alloys to Weathering and Resistance of Aluminum Alloys to Chemically Contaminated Atmospheres*

Name_____ Title_____
Company_____
Address_____
City_____ Zone_____ State_____

STOCKHAM'S WEDGEPLUG O-SEAL VALVE

Does the Work of 2 Valves!

BUBBLE-TIGHT SHUT-OFF on both the upstream and downstream seats is provided by the pressure-sealing effect of the two Teflon*"O" rings in the plug.

FIRESAFE: If Teflon "O" rings are burned out, an effective shut-off is made by ground metal to metal seats.

TELL-TALE BLEED to check valve performance assures no product mixing in manifold.

NON-LUBRICATED — the O-Seal eliminates the high daily cost of lubrication, as well as the danger of product contamination caused by plug-seal lubricants.

GUARANTEED not to stick.

*Teflon, Dupont trademark

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Bronze, Cast Iron, Ductile Iron, Cast and Forged Steel Valves
Cast Iron, Malleable and Ductile Iron Pipe Fittings

WEDGEPLUG VALVE COMPANY DIVISION

STOCKHAM
VALVES *and* FITTINGS

General Offices and Plant
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Men . . .

partment, received his B.S. degree in chemical engineering at the University of Michigan in 1937, and a year later, he took a master's degree at the same university.

Bartlett Johnston has been promoted to staff engineer in the Technical Division, Humble Oil & Refining Co.'s Baytown, Texas, refinery. He is in the economic analysis section and is engaged in developing calculation methods and techniques for the application of large electronic computers to optimize the blending of motor and aviation fuels. Johnston holds a B.S. degree in chemical engineering from Vanderbilt and an M.S. degree from the University of Michigan.

Johnston

L. E. Cranston has been named general manager of Mobil Oil Co.'s Beaumont, Texas, refinery. He succeeds **R. G. Sanders,** who has retired after more than 40 years of service. A former manager of Mobil's Paulsboro, N. J., refinery, Cranston will be in charge of the refinery, as well as the Magpetco terminal at Port Neches, Texas, underground storage facilities near Hull, Texas, and other facilities. He has been assistant general manager of the Beaumont plant since January 1. He joined Mobil in 1931 at the Augusta, Kan., refinery and transferred to the Manufacturing Department in New York in 1950.

Sanders

Cranston

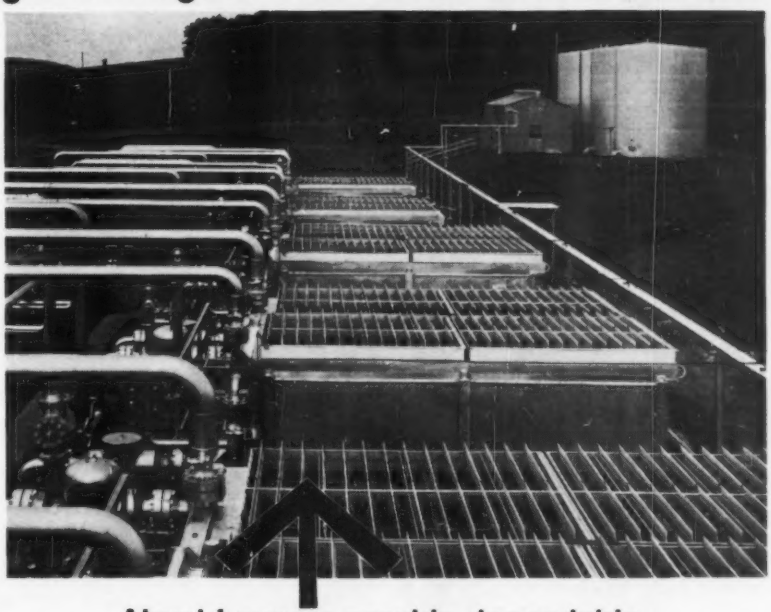
— Deaths —

James H. Lewis, 74, of Los Angeles died May 6. A pioneer West Coast oil executive, Lewis at one time was president of Sunset Oil Co. and was a former executive vice president, Independent Refiners Association of California.

Henry E. Bedford, 75, a retired Standard Oil Co. (New Jersey) executive in Europe, died May 4 in Baltimore, Md.

from ALCOA

good designs made better with aluminum



Alumi-Louvers provide dependable, economical ventilation at New York State Natural Gas Co.

For uninterrupted, maintenance-free performance, Mansfield Metal Fabricating Co., Mansfield, Ohio, constructs its famous *Alumi-Louvers* of Alcoa® Aluminum. A typical installation (shown) is at New York State Natural Gas Co., Tamarack, Pa. *Alumi-Louvers* require no maintenance, provide dependable, economical control of ventilation and temperature. Mansfield reports that lightweight aluminum cuts transportation and installation costs (special rigging is unnecessary). For more information about corrosion-resistant aluminum, please send the coupon.

ALCOA ALUMINUM
ALUMINUM COMPANY OF AMERICA

Aluminum Company of America, 827-TT Alcoa Building, Pittsburgh 19, Pa.
Please send me the following literature covering Alcoa Aluminum for tubular products and other uses in the process industries.

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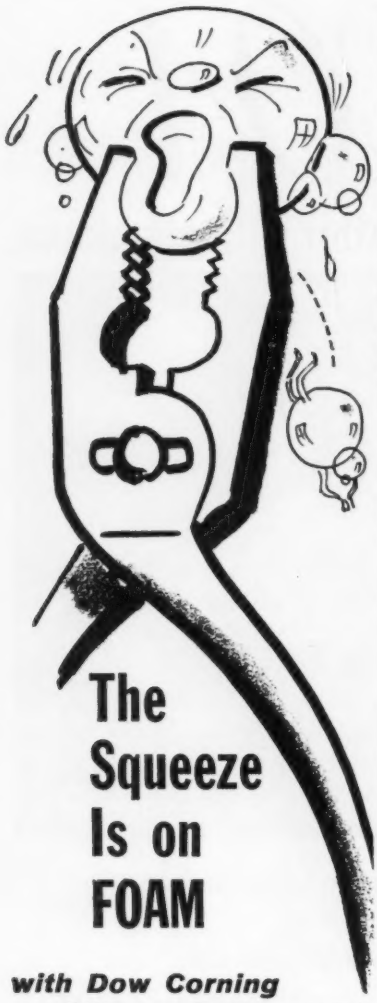
- ☐ 42-20849 *Resistance of Aluminum Alloys to Weathering and Resistance of Aluminum Alloys to Chemically Contaminated Atmospheres*
- ☐ 61-21088 *Aluminum Cooling Towers and Their Treatment*
- ☐ 34-11566 *Alcoa Aluminum Heat Exchanger Tubes*

Name_____ Title_____
Company_____
Address_____
City_____ Zone_____ State_____



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There's a *right* tool for every job. In foam control it's Dow Corning silicone antifoamers or defoamers . . . job-proved thousands of times over as the most efficient, most economical, and most versatile foam suppressors available.

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Please rush a FREE SAMPLE of a Dow Corning silicone defoamer for my product or process, which is (indicate if food, aqueous, oil or other): _____

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COMPANY _____

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New Books...

As selected by the editors of HYDROCARBON PROCESSING & PETROLEUM REFINER

Polyolefin Resin Processes

"Polyolefin Resin Processes" provides a comprehensive review of U.S. patents in the polyolefin resin process field. It lists all U.S. polyolefin patents in order of application and contains patent application serial number, date, U.S. patent number and book reference number.

The book covers solid (rather than liquid or viscous) polymers and concentrates on resins, homopolymers of aliphatic mono-olefins and some copolymers of olefins with other olefinic hydrocarbons.

(Sittig, Marshall, *Polyolefin Resin Processes,* Gulf Publishing Co., Book Division, P. O. Box 2608, Houston 1, Texas, 240 pages, $6.50.)

Computer Handbook

"An Introduction to Digital Computers" is an introduction to electronic digital computers, with a preliminary guide to computer programing. It is written for those who do not have specialized knowledge of electronics or digital computing.

The report cites some of the varied uses of computers in science, engineering and business, surveys uses psychologists have found for computers, reviews mathematical aspects of digital computing, and discusses practical factors of computer programing.

(Green, B. F., Jr., *An Introduction to Digital Computers,* United States Department of Commerce, Business and Defense Services Administration, Office of Technical Services, Washington 25, D. C., 46 pages, $1.25.)

Microanalysis

"Microanalysis by the Ring Oven Technique" tells about an analytical technique originally developed as a qualitative separation technique for extremely minute samples. This book should find wide application in different branches of analytical chemistry.

Within the past few years the methods have been extended to semi-quantitative analysis, to the analysis of radioactive substances, to electrographic analysis, and the like.

(Weisz, Herbert, *Microanalysis by the Ring Oven Technique,* Pergamon Press, Inc., 122 East 55th St., New York 22, N.Y.)

Lubricating Oils

"Lubricating Oils: For Industrial and Heavy Duty Automotive Engines" is a pocket-sized booklet which lists the names of about 750 oil companies and the brands of their oils which they each guarantee meet the test requirements of U.S. Military Specification MIL-L-2104A and/or British Defense Specification DEF/2101B, as well as the Supplement 1 (S-1) and the Series 3 (Caterpillar) test specifications.

Although no individual product specifications are listed, the booklet is useful for its tabulation of commercially available oils.

(Lubricating Oils: For Industrial and Heavy Duty Automotive Engines, Internal Combustion Engine Institute, 201 N. Wells St., Chicago 6, Ill., 75 pages, 35 cents.)

Packings Handbook

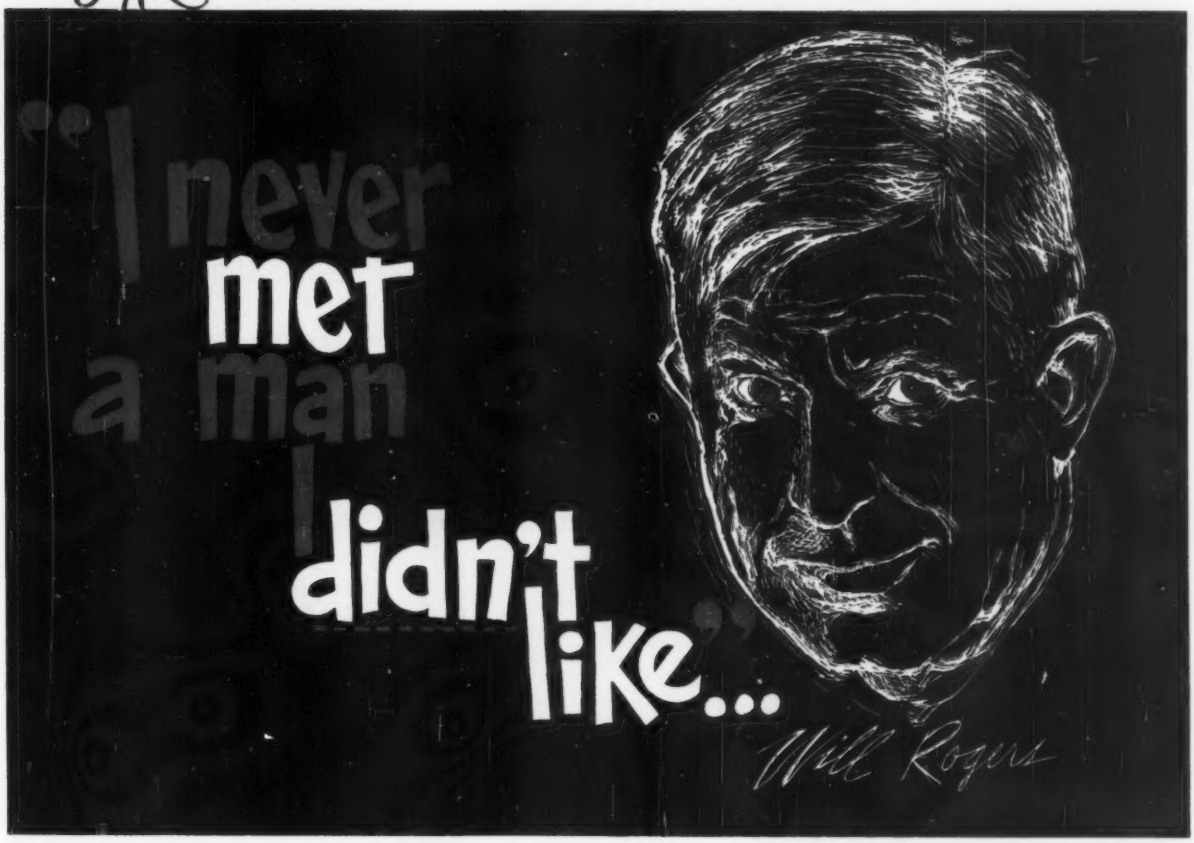
"Handbook of Mechanical Packings and Gasket Materials" is a reference book on mechanical packings and gasket materials affording a most useful service to manufacturers using these necessary products. It presents:

- American standards for nonmetallic gaskets for pipe flanges,
- Recommended standards for stuffing box dimensions,
- Technical data on mechanical packings, gaskets, mechanical seals and piston rings.

The book is a compilation of a series of articles researched and written by Steve Elonka and originally published as special reports in Power.

(*Handbook of Mechanical Packings and Gasket Materials,* Mechanical Packing Association, Inc., 17 John St., New York 38, N. Y., 109 pages, $2.50.)

A WESTERN APPROACH



Will Rogers expressed the heart and soul of our country and its people. If it's remarkable that he never met a man he didn't like — it's even more remarkable that there was never a man that didn't like him. Will Rogers dedicated his life to service to his countrymen.

. . . at Western, we, too, are dedicated to service to the petroleum and petrochemical industries. We like the people we deal with, and we hope our high standards of design, engineering and fabricating merit their confidence.

The Heat Exchanger Division of Western Supply Co. designs and fabricates Fixed Tube Sheet, U-Tube, and Floating Head Exchangers. We're specialists in heat-transfer problems. We hope we may work with you serving in the fields we know best.

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For more data on advertised products, use cards, last page.

Books . . .

Crude Oil Measurements

"Measuring, Sampling and Testing Crude Oil," second edition of API Standard 2500, contains information on measuring liquid volume, temperature, measurement, sampling, gravity determination, vapor pressure determination, and quantity adjustments and calculations.

Also included are sections on basic sediment and water, automatic gauging devices, automatic temperature devices, automatic line samplers, lease automatic custody transfer systems, and marine-liquid bulk carriers.

(*Measuring, Sampling and Testing Crude Oil,* American Petroleum Institute, 1271 Avenue of the Americas, New York 20, N. Y., 65 pages, $1.)

Insulation Manual

"Manual on Economic Thickness of Insulation for Flat Surfaces and Pipes" provides a practical means for specifying the thickness of thermal insulation needed for maximum economy. By referring to charts in the book, an engineer can quickly find the solution for any of billions of possible combinations of variables, involving cost of heat energy, cost of insulation, cost of capital at various periods of amortization, and conductivities of various insulations at different temperatures.

(Arents, C. A.; Cather, H. M., and Dubbe, E. C., West Virginia University, and Comerford, F. G.; Hollenbeck, W. J.; Malloy, J. F., and Turner, W. C., Union Carbide Chemicals Co., *Manual on Economic Thickness of Insulation for Flat Surfaces and Pipes,* Engineering Experiment Station, West Virginia University, Morgantown, W. Va., 177 pages, $10.)

Petroleum Terms

"A Glossary of Petroleum Terms" is a glossary of special terms used in the petroleum industry with definitions which, even if not exhaustive or highly technical, are accurate and informative. In the present (third) edition of this glossary, an extension has been made and many more terms included as well as two useful appendixes on terms used in petroleum legislation (United Kingdom) and abbreviations for the titles of many official bodies.

(*A Glossary of Petroleum Terms,* The Institute of Petroleum, 61 New Cavendish St., London, W. 1., England, 39 pages, $1.20.)

Government Statistics

"Guide to U.S. Government Statistics" gives a compact, yet comprehensive, reference tool to statistical data in the United States. It covers over 2,000 items, including the recurring publications, the statistical series, and the many important one-time publications of statistical value.

(Andriot, John L., *Guide to U.S. Government Statistics,* Documents Index, P. O. Box 453, Arlington 10, Va., 401 pages, $15.)

Equipment Preparation

"Chapter V, Preparation of Equipment for Safe Entry and Work," the "Guide for Inspection of Refinery Equipment," covers the preparatory work, inspections and tests which should be undertaken to assure that equipment has been properly cleaned and gas-freed and is safe for opening, entry and work.

(*Chapter V, Preparation of Equipment for Safe Entry and Work, Guide for Inspection of Refinery Equipment,* American Petroleum Institute, Publications Department, 1271 Avenue of the Americas, New York 20, N. Y., 75 cents.)

Conversion Factors

"Industrial Research Service's Conversion Factors and Tables" contains factors for conversion of weights and measures in the United States and 95 foreign countries. English to metric units and vice versa will be easier with this handy set of tables. The foreign units are listed by countries for easy reference.

(Zimmerman, O.T.; Lavine, Irvin, *Industrial Research Service's Conversion Factors and Tables,* third edition, Industrial Research Service, Inc., Dover N.H. 710 pages, $7.50.)

9 YEARS AND 973 JOBS LATER!
SMITHCO, whose only business is air cooled heat exchangers, has filled 973 separate orders since 1951. We hope you'll pardon us if our pride shows a little, but we believe our nine year record of continuous growth deserves your attention.
During our brief history we have seen air cooling evolve from an experiment to an exact science. First we cooled water, then gas. As we gained experience and know-how, we successfully met and overcame the problems involved in the cooling and condensing of light hydrocarbons. Today, SMITHCO is able to apply air cooling to any material that will flow through tubes.
One prominent reason for the wide acceptance of our coolers is the Molecular Bond fin tube. SMITHCO is the only builder of industrial air cooled heat exchangers that provides this unique engineering feature which furnishes an uninterrupted metallic thermal path for flow of heat from the inside of the tube to the outermost edge of the fin.
When cooling problems arise, why not put our nine years of progress to work for you? SMITHCO has the facilities and engineering ability to produce a complete range of air cooled heat exchangers from the simple water cooler to the most complicated process coolers and condensers.
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Combination Iso-stripper Recycle Condenser and Debutanizer Condenser in a Western Refinery.

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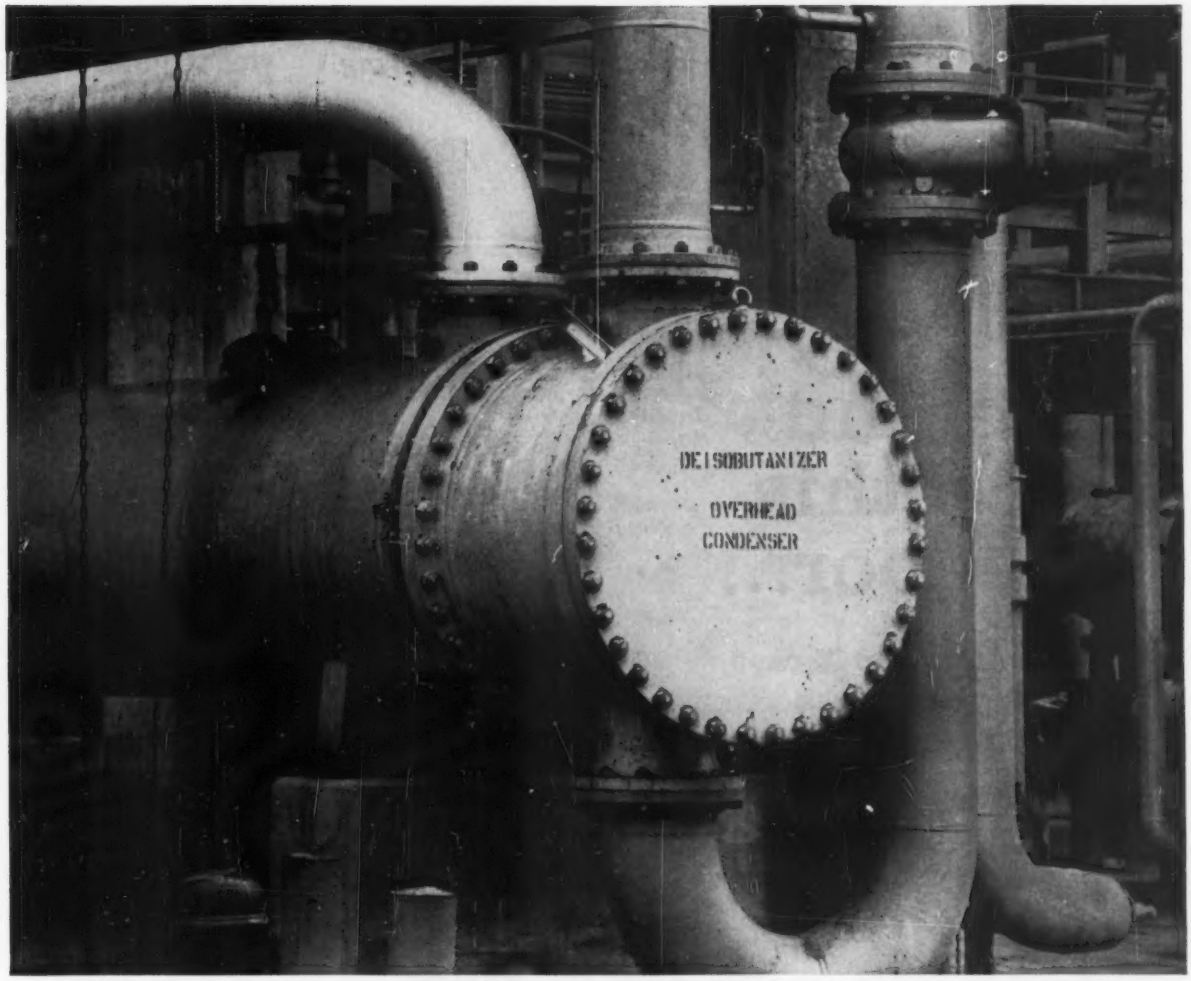

While the DIB overhead condenser continued operating, heavy deposits were cleaned out in just thirty minutes, tripling condenser throughput.

THIRTY-MINUTE CLEANING WHILE IN USE BOOSTED CONDENSER THROUGHPUT FROM 500 TO 1500 BPD!

In just thirty minutes, Dow Industrial Service engineers cleaned an overhead vapor condenser on a deisobutanizer column *while in operation!*

This half-hour chemical cleaning job tripled throughput—from 500 bbls. to 1500 bbls. per day—at a minimum cleaning cost! Any other cleaning method would have pulled the column out of operation, and sent the total cost of cleaning sky-high!

Nation-wide Dow Industrial Service cleans every kind of refinery plant equipment, anywhere in the U. S. . . . thoroughly, economically, often with little or no equipment downtime. D.I.S. refinery specialists can choose from a wide range of cleaning techniques and equipment—many D.I.S. developed—to bring your equipment back to maximum operating efficiency, quickly.

Heat exchange equipment, condenser bundles, towers, piping . . . whatever the equipment, D.I.S. has the experience and facilities to serve you best. Dow Industrial Service also offers consulting laboratory service for water treatment and waste processing problems, backed by the technical resources of THE DOW CHEMICAL COMPANY. For cleaning *any kind* of equipment, *anywhere* in the U. S., write or call DOW INDUSTRIAL SERVICE, Dept. HP&PR 6, 20575 Center Ridge Road, Cleveland 16, Ohio.

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For more data on advertised products, use cards, last page.

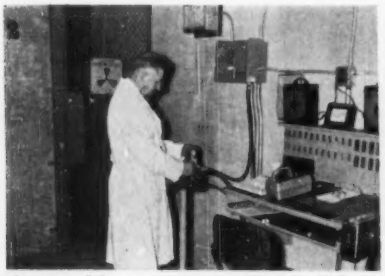
Adding new dimensions *to engineering*

Behind this door...

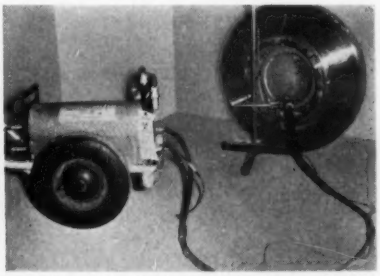
gamma- and X-rays stop centrifugal compressor problems before they start

We inspect centrifugal compressors *from the inside-out* at our new Non-Destructive Testing Laboratory. Using cobalt 60, iridium 192 or 160-KV X-ray equipment, we look all the way through centrifugal compressor parts to be certain they are free from defects. This extra care in manufacture means extra dependability in the field. It's another reason why users of Ingersoll-Rand centrifugal compressors can expect...and get...more reliable, trouble-free operation.

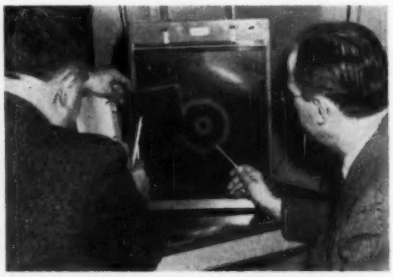
Controlled from a remote station...gamma rays probe deep...to provide visible internal inspection



At one of 3 test stations, an Ingersoll-Rand radiographer uses remote controls to place radioactive pellets of iridium or cobalt in the exposed position...



...within the thick concrete test cell. The gamma rays penetrate the compressor part and expose the film. The radioactive pellet is then returned to its shielded container.



The developed radiographic view is carefully inspected by I-R metallurgists to be certain that the part is free from defects. Radiography is one of many non-destructive testing methods used by Ingersoll-Rand.

THE WORLD'S MOST COMPREHENSIVE COMPRESSOR EXPERIENCE

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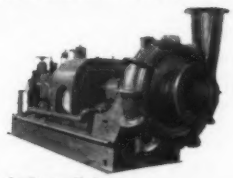
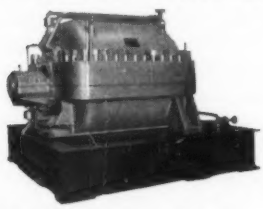
Why Ingersoll-Rand can supply EXACTLY WHAT YOU WANT in a Centrifugal Compressor

MORE TYPES AND SIZES to choose from



Single-Stage Units
Pressures to 1000 psi
Capacities to 700,000 cfm



Multi-Stage, Horizontally Split
Pressures to 800 psi
Capacities to 200,000 cfm

Multi-Stage, Vertically Split
Pressures to 5500 psi
Capacities to 20,000 cfm

Intercooled 100-psi Units

These four basic casing types can be combined into multiple-unit installations to meet any pressure and capacity requirement. And every design features . . .

GREATER ADAPTABILITY to meet your specific needs. Seals, cooling methods and side-load connections are just a few of the many design details that can be "tailored" to each installation. What's more, every compressor is backed by . . .

MORE THOROUGH TESTING in the world's largest and best-equipped compressor test facility. Here new centrifugal designs, components, accessories and complete machines can be tested, frequently at full load and under simulated operating conditions.

5 MILLION HORSEPOWER of I-R centrifugal compressors are serving all types of applications throughout industry.

283A12

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11 Broadway, New York 4, N. Y.

Meetings Calendar

June

9-17.....**European Convention of Chemical Engineering,** 13th Chemical Engineering Exhibition & Congress, Frankfurt, Germany.
11-15.....**American Society of Mechanical Engineers,** Summer Annual Meeting, Statler Hilton Hotel, Los Angeles, Calif.
-12.....**Instrument Society of America,** Air Pollution Control Association, Air Pollution Instrumentation Symposium, Hotel Commodore, New York City.
12-15.....**Gordon Research Conference**—Petroleum—Colby Junior College, New London, N. H.
13-16.....**ISA,** Gas Chromatography Symposium, Kellogg Center, Michigan State University, East Lansing, Mich.
19-23.....**Gordon Research Conference**—Catalysis—Colby Junior College, New London, N. H.
21-23.....**American Association of Cost Engineers,** Annual Meeting, Boston, Mass.
28-30.....**ISA, AIChE, AIEE, ASME, IRE,** Automatic Control Conference, University of Colorado, Boulder, Col.

July

18-20.....**Western Plant Maintenance and Engineering Show,** Pan Pacific Auditorium, Los Angeles, Calif.

August

14-17.....**Society of Automotive Engineers,** National West Coast Meeting, Sheraton Hotel, Portland, Ore.
28-Sept. 1.....**ASME,** International Heat Transfer Conference, University of Colorado, Boulder, Colo.

September

3- 8.....**American Chemical Society,** Fall Meeting, Chicago, Ill.
5- 8.....**ACS,** National Chemical Exposition, Chicago Amphitheater, Chicago, Ill.
11-15.....**ISA,** Fall Instrument-Automation Conference & Exhibit, Biltmore Hotel, Memorial Sports Arena, Los Angeles, Calif.
-14.....**Natural Gasoline Association of America,** Rocky Mountain Regional Meet, Northern Hotel, Billings, Mont.
14-15.....**ASME, AIEE,** Engineering Management Conference, The Roosevelt Hotel, New York City.
20-21.....**Western Petroleum Refiners Association,** Rocky Mountain Regional Technical-Industrial Relations Meeting, Henning Hotel, Casper, Wyo.
24-27.....**ASME,** Petroleum Mechanical Engineering Conference, Hotel Muehlebach, Kansas City, Mo.

October

4- 6.....**ASME, Process Industries Conference,** Shamrock Hilton Hotel, Houston, Texas.
11-12.....**WPRA,** Waste Disposal and Stream Pollution Conference. Hotel Lassen, Wichita, Kan.
12-13.....**California Natural Gasoline Association,** Annual Fall Meeting, Lafayette Hotel, Long Beach, Calif.
25-26.....**WPRA,** Annual Question and Answer Session on Refining Technology, Rufus Garrett Hotel, El Dorado, Ark.
-27.....**NGAA,** Southern Regional Meeting, Carlton Hotel, Tyler, Texas.
29-Nov. 1.....**National Lubricating Grease Institute,** Annual Meeting, Rice Hotel, Houston, Texas.

November

9-10.....**SAE,** National Fuels & Lubricants Meeting, Shamrock Hilton Hotel, Houston, Texas.
13-15.....**American Petroleum Institute,** Annual Meeting, Conrad Hilton Hotel, Chicago, Ill.
-17.....**NGAA,** Panhandle Plains Regional Meeting, Herring Hotel, Amarillo, Texas.
26-Dec. 1.....**ASME,** Winter Annual Meeting, Statler Hilton Hotel, New York, N. Y.
27-Dec. 1.....**Exposition of Chemical Industries,** New York Coliseum, New York, N. Y.

December

5- 6.....**WPRA,** Computer Conference for Refiners, Hotel Tulsa, Tulsa, Okla.

. . . one of a series presented by Western Supply Company, Tulsa, to improve the "I. Q."* of engineers . . .
(*"Income Quotient")

NEW-PRODUCT DEVELOPMENT VITAL TO INDUSTRY

Industrial "fairy tales" are few and far between, but here's one with more than a grain of truth. The situation, as you will recognize, has been duplicated frequently, and industry consequently suffers the waste of millions of dollars, as well as an equal amount of man hours and energy, annually — while such stories come true.

Before embarking on the short tale, however, it must be acknowledged that in today's highly accelerated economy, most companies cannot survive without new products or services for their various "publics." At this very moment, in all phases of industry, there are declining products. There are manpower and production facilities that must be utilized more profitably. *And it is to the engineers of today that industry looks for the new products and services of the future.* The road to successful new-product development, however, has many hazards, pitfalls and limitations, and insists on a realistic appraisal and appreciation of *all* the phases of development. Perhaps the following "tale" is an oversimplification, but it will serve at least to introduce the subject for closer inspection.

Once upon a time, a sharp young man named Eddie Engineer had a whopper of an idea. He thought to himself: "If I can design this Widgit, I'll bet lots of people would be glad to pay $1 for it." That very day, he went to his drafting board and started designing his Widgit. After an infinite number of calculations and endless days, he finished his design.

But, Eddie Engineer was a *thinker*, not a *maker*, so he had to find someone to manufacture the Widgit. He found the best manufacturer in his locality, a man of good reputation named Freddie Fabricator. He showed Freddie his plans and convinced him that people would easily pay $1 for a Widgit. Freddie wanted to join in the enterprise, but he had to admit, "I suppose they would pay $1 for it, but it will cost at least $2 to make one of these Widgits, even on a volume basis."

So, poor, dejected Eddie had learned an expensive lesson, because all of his time and effort had gone for naught. If his time had been dollars, he'd have been broke.

Not long after, he had another whopper of an idea, this time for a Gidgit. Before he sharpened a pencil, he went over to see Freddie. Freddie could make the Gidgit and they thought people would pay $2 for one.

FOOTNOTE: For the climax to this tale — and for its possible significance to your professional advancement, write for your complimentary copy of "New Product Development", Booklet E-11, to: Western Supply Company, Heat Exchanger Division, P. O. Box 1888, Tulsa, Okla. — where product development keeps pace with progress in the petroleum and petro-chemical industries.

Happenings . . . (continued from page 45)

increase 240 percent, in the 1959-65 period. More emphasis will be placed on refining diesel fuel, to keep up with the manufacture of diesel-powered tractors. Other observations: About one fifth of all Soviet crude production is exported, with Western Europe the main target area. From 1956-60 U.S.S.R. production hit 2.96 million bpd.

Meanwhile, Bureau of Mines specialist Donald Frendzel sees at least one hopeful note in the Russian threat: Long-term trade pacts favorable to both the U.S.S.R. and the West would tend to build up political stability. As the Soviets inch ever closer to surpassing Venezuela as the world's number two crude producer, this bleak picture emerges:

- The Iron Curtain with extra card in world-power game
- Extra surpluses in already excessive world stocks
- Tightened Soviet trade relations with neutral and free-world-committed countries.
- Tied-up production and marketing in underdeveloped countries where Soviets promise to build refineries and supply crude.
- Increased activity in world sulfur market (increased refining means more extraction of sulfur from Russia's high-sulfur crudes.)

But a happier note includes:

- Benefits from increased economic competition
- Security for consumer countries now dependent on Middle East oil.
- Security for Middle East through development of Soviet's oil at home, easing Russian pressure for political control.
- Economic interdependence in a world community—easing chances of war.

Danger in TML?

Withdrawal of the use of TML as a gasoline additive in Italy has been requested by Italian Senator Luigi Preti. The senator charges the fumes from gasoline containing TML hold 70 to 100 times more lead than gasoline using the conventional TEL. The additive's great volatility has proven to be a tremendous advantage in foreign cars, where there is a problem of even distribution over all cylinders. For this reason, TML has been expected to capture the whole European antiknock market by 1963. The rebuttal to Preti's charge: Mobiloil Italiana and Esso Standard Italiana claim skin penetrability of TML is only one-tenth that of TEL, so volatility isn't a key factor.

Where Did It Go?

If you're one of those readers who is wondering what's happening to "What's Happening in HPI" . . . here's the straight scoop: This timely news department has been moved to the front of the magazine (Page 39 in this issue) where you will find these added features, (1) a "full-page" type of presentation to faciliate fast, condensed reading, (2) a "snappier" easy-to-read writing style, (3) *interpertative* reporting on trends and news in the HPI, and (4) more thorough coverage than ever before. So from here on, look for your HPI news "up front."

Government & Labor

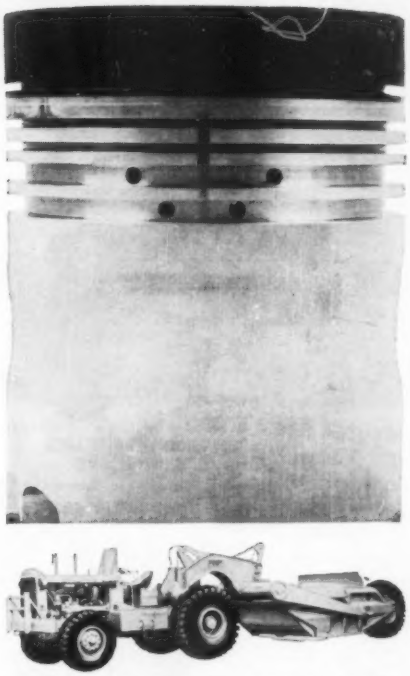
Agencies OK Fuel Study

Federal Government Agencies have lined up solidly in favor of a special nine-man Senate committee to make a national fuels policy study. The seven polled responded like this: For the study, Interstate Commerce Commission; Office of Civil and Defense Mobilization; State Department; Budget Bureau; Atomic Energy Commission; and Department of the Interior. Federal Power Commission took no position. The State Department's Assistant Secretary Brooks Hays urged that the fuel study include such international ramifications as the role of coal exports in the U.S. balance of payments, the role of oil and atomic power in foreign relations, and the effects on one geographic or economic area of energy policies adopted in the other.

The above seven agencies will testify at June 22-23 hearings on the

NEW PARANOX® 221

An improved detergent inhibitor designed for Series 3 lubricants



Test piston from Caterpillar 1-G supercharged diesel engine after 480 hours operation with Series 3 lubricant. Clean ring zone emphasizes excellent detergent-inhibition properties of new Paranox 221.

Paranox 221, a new detergent-inhibitor package, is a potent additive for formulating Series 3 Oils. These lubricants are required to meet the severe lubrication needs of all engines found in heavy duty diesel equipment. Oils formulated with only 11-12 volume % of Paranox 221 will meet these demanding requirements.

The outstanding property of Paranox 221 is its excellent detergent inhibition action in base oils, demonstrated by high piston cleanliness in Caterpillar 1-D and 1-G (shown above) supercharged engine tests. It also imparts long-term oxidation stability, rust protection and antifoam properties to finished lubricants. Because of these properties, a Series 3 lubricant formulated with Paranox 221 can be effectively used in various other applications where the equipment manufacturer recommends Series 3 oil, such as transmissions and final drives.

For a comprehensive new bulletin on Paranox 221, write to Enjay at 15 West 51st Street, New York 19, New York.

EXCITING NEW PRODUCTS THROUGH PETRO-CHEMISTRY

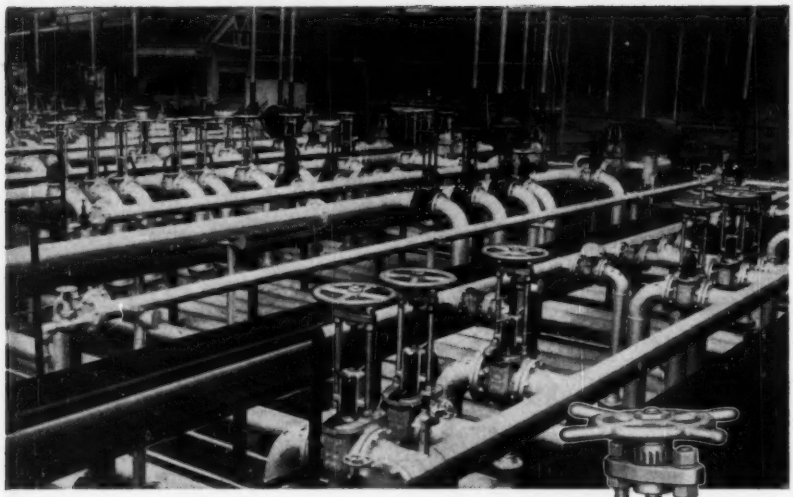
ENJAY CHEMICAL COMPANY

A DIVISION OF HUMBLE OIL & REFINING COMPANY

ENJAY

ADDITIVES

For more data on advertised products, use cards, last page.

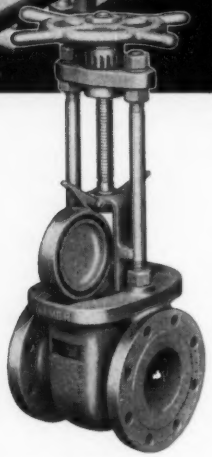


SAVE 90% AND MORE

ON LINE BLINDING COSTS

with

HAMER LINE BLIND VALVES

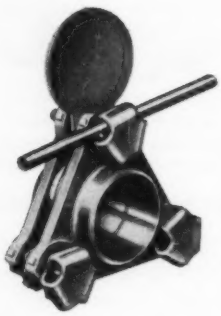


VISIBLE WEDGE LINE BLIND VALVE
No line movement necessary to operate. No spillage or loss of product.

It takes one man just a few minutes to open and close a Hamer Line Blind Valve. Compare this with the old fashioned method of inserting and removing a "skillet" blind between multi-bolt flanges. Cost records from scores of users show Hamer Line Blind Valves save 90% and more every time a line is blinded. Multiply these savings by the number of lines and times they have to be blinded and you can quickly see why Hamer Line Blind Valves pay out fast.

Furthermore there is no product loss with most models of Hamer Line Blind Valves. Simplicity, positive visible shut-off, no contamination and safety are added benefits of Hamer Line Blind Valves.

Hamer valves are applicable wherever lines require blinding. They are available in special alloys and with special trim for severe conditions. Write for Hamer Catalog 60 for complete description of all types, sizes and pressure ratings.



3-BOLT LINE BLIND VALVE
Particularly suited for installations where slight spillage and line spreading are no problems.

WECO WELL EQUIPMENT MFG. CORP.
HOUSTON, TEXAS
Division of CHIKSAN COMPANY a subsidiary of FOOD MACHINERY AND CHEMICAL CORPORATION
HV-2-61
fmc

WECO UNIONS

CHIKSAN SWIVEL JOINTS

HAMER LINE BLIND VALVES

HAMER PLUG VALVES

WECO AIR-O-UNION

WECO COMPOUNDS

WECO SNATCH BLOCKS

Happenings . . .

national-fuels-policy-study-resolution. The pro-fuels-policy coal group in Washington is encouraged by the likelihood that the current session of Congress will continue into early fall. This won't hurt chances the resolution will be passed.

Craft Union Raiding

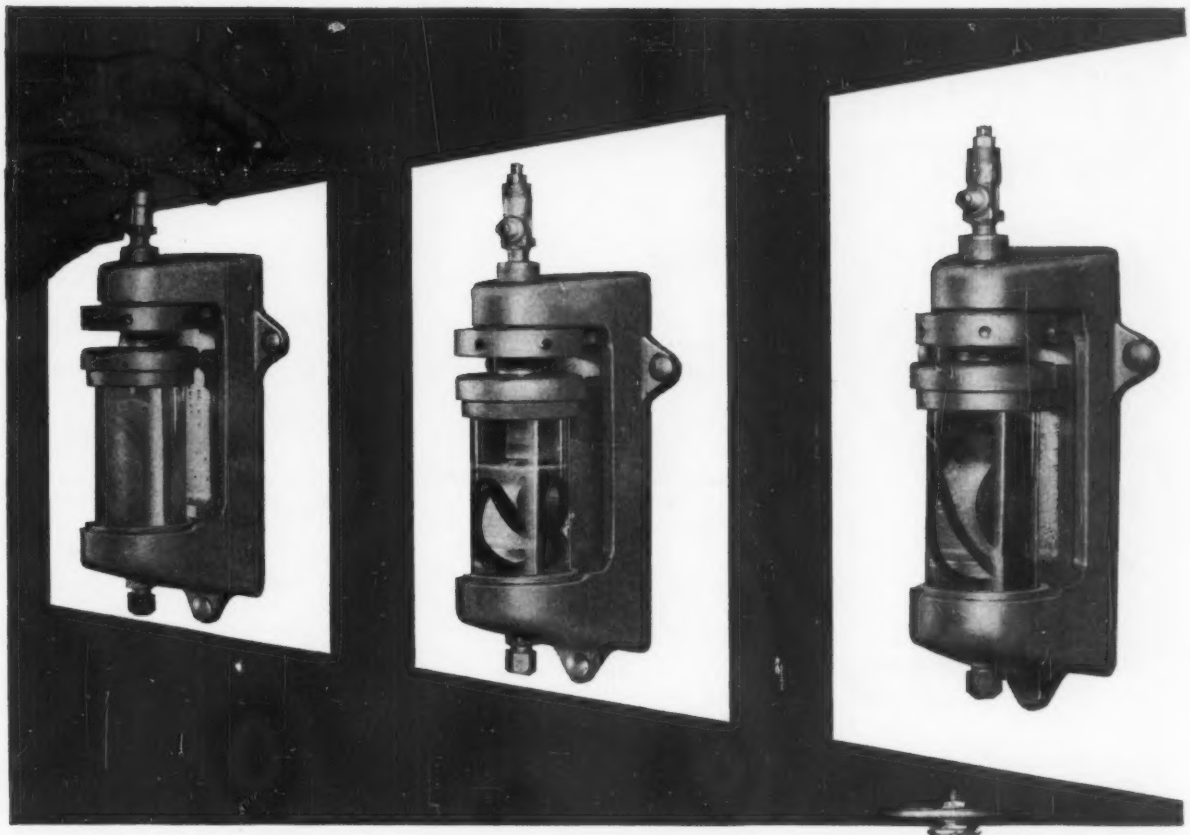
The National Labor Relations Board has received a statement from the National Petroleum Association urging the former to reaffirm its decision to prevent craft unions from breaking up plant-wide bargaining units. In February, in a case involving American Cyanamid, the board decided to prevent the indiscriminate raiding of plant-wide unions. The NPA points out that the traditional pattern of organization within the industry has been a single plant-wide unit. It is estimated that less than 5 percent of the nation's more than 300 petroleum refineries have more than one bargaining unit.

The Association's position: "We are convinced that the objective of the Labor-Management Relations Act is to promote industrial peace through the continuation of bargaining patterns which have been worked out in practice." NPA referred to frequent transfers of jobs that take place in any refinery, especially at times when one section is busy or slack. "These transfers negate the idea that refinery employes form a distinct, homogeneous group of skilled journeymen craftsmen, working as such. Therefore, refinery employes should not be organized by craft unions."

Changing Times

California Chemical and Standard Oil-California form a new company in Japan to make and sell lubricating oil additives and alkylphenols. Karonite Chemical Co., Ltd., the new firm, is owned 45 percent by Calchem.

Asphalt-paved mileage on state highways nearly doubles since the end of World War II. According to figures from the Asphalt Institute, asphalt paving, which totaled 242,248 miles in 1945, had reached 478,455 miles in 1959.



Kerotest Valve Parts Get the ALL CLEAR FROM BOMBS

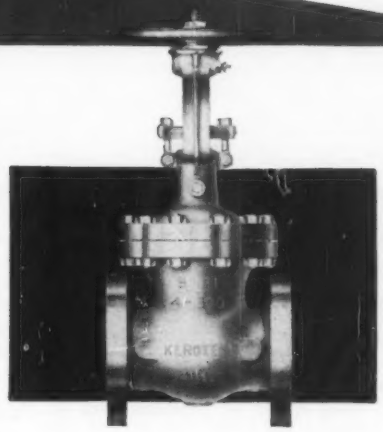
All materials and parts that go into Kerotest Valves must first get the all clear in these pressurized material test bombs at the Kerotest laboratories. Packings, plastics, gaskets, O-rings, seat rings, steel, and other materials are accepted as suitable only after they've withstood the deteriorating effects of various gases, vapors, liquids and refrigerants for specified test periods.

Kerotest quality controls are applied from the initial development and engineering phase to the final assembled valve. For those who specify and use Kerotest Valves these high standards of material and production quality mean greater valve value per dollar. With Kerotest there's minimum risk of valve failure in service and improved operating efficiency with less maintenance.

Kerotest Cast Steel Gate Valves

High quality Kerotest cast steel gate valves are available in primary service pressure ratings ranging from Series 150 to Series 1500. They are supplied in various combinations of body and trim material for all types of service in oil, gas, steam, water, chemical, petro-chemical, marine and industrial installations.

Send for your free copy of the new, informative Kerotest booklet. It's packed with working tables, dimensions, specifications and other helpful information.



KEROTEST
Quality Controlled Features

- Reinforced wall sections guard against unusual strains — erosion and corrosion.
- Built for repacking under pressure in the full open position.
- Deep stuffing box for greater packing life and tighter seal.
- Threaded, bottom seating type seat rings. Made without protruding lugs to permit full clear way opening through valves.
- All yokes made to withstand rough handling and equipped with lubrication fitting to stem nut.

There is a Kerotest Cast Steel Valve available for every class and condition of service.

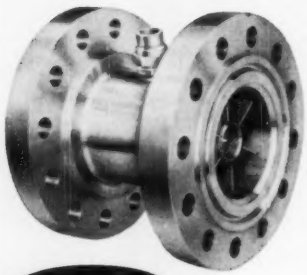
KEROTEST MANUFACTURING COMPANY
2514 LIBERTY AVENUE • PITTSBURGH 22, PA.

In Canada... Kerotest Cast Steel Valves are manufactured and distributed exclusively by Guelph Engineering Company, Guelph, Ontario, Canada

KEROTEST®

For more data on advertised products, use cards, last page.

COX TURBINE FLOWMETERS



RUGGED

ACCURATE

RELIABLE

SERVICEABLE

Cox Turbine Flowmeters are gaining new acceptance with engineers and field meter men in refineries, pipelines and petro-chemical process plants as the "ideal" meter.

Here's why:

- *Low first cost*
- *Low maintenance*
- *Easy to install*
- *Readily replaces existing totalizing meters adding flow rate and control*
- *Sustained meter factor over wide range of products and flow rates*
- *Excellent repeatability*
- *Suitable for totalizing, recording, telemetry, control and blending applications*

For detailed information write for Handbook on Petroleum Measurement and Control Systems, Bulletin No. 4000.

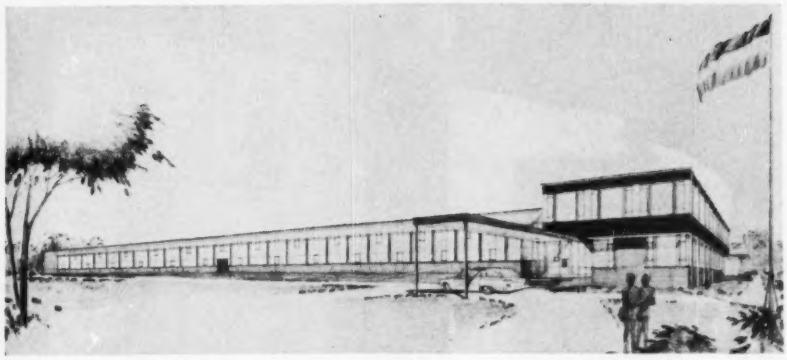
COX INSTRUMENTS

Division of

GEORGE L. NANKERVIS COMPANY

15300 Fullerton • Detroit, Michigan

Suppliers Notes...



Architect's drawing shows Foxboro (Nederland) N.V.'s new plant opened last month in Soest, Holland. The building has over 23,000 square feet of factory and warehouse space, a boiler room and a two-story office.

W-K-M DIVISION, ACF Industries, Inc., has promoted **Paul R. Nagle** to northeastern district manager. Nagle will handle sales in the New York area for the division's lines of valves, fittings, sealing compounds and lubricants. He was formerly with Andreason-Lundberg, W-K-M's export representative.

CLAYTON MARK & CO. has named **James B. Carse** general sales manager. Carse was formerly director of market development for Rust-Oleum Corp. Clayton Mark manufactures water systems, industrial forged steel products, electrical steel conduit and steel tubing.

NATIONAL TUBE DIVISION, U.S. Steel Corp., has promoted **Paul C. Ely** to general manager, operations. Ely will be in charge of manufacturing for National Tube's six plants. He was formerly assistant vice president, operations, tubing specialties.

THOR POWER TOOL CO. has named **Milton E. Slater** executive assistant to the president. Slater has been with the company since 1948 in the Sales Department. He will headquarter at the firm's administration offices in Aurora, Ill.

RIDGE TOOL CO. has named **Gordon M. Henderson** salesman for Florida. Henderson, who will sell Ridge pipe tools, will headquarter in Miami.

HAMILTON MANUFACTURING CO.'s executive vice president, **R. G. Halvorsen,** has been elected president of Scientific Apparatus Makers Association. He succeeds **Dr. G. A. Downsbrough,** president, Boonton Radio Corp.

FARRIS ENGINEERING CORP. has named **Glen Chase** product manager of its Mill Division. Farris Engineering manufactures safety-relief valves, flexible valves, air preheaters, take-off machines and steam traps. Before joining Farris, Chase was with Yarnall-Waring Co.

GRAY TOOL CO.'s Grayloc Sales Division has appointed W. G. Hayden Co., Cleveland, Ohio, sales representative for Northern Ohio. George A. Whittet Co., Dallas, Texas, will handle sales for Gray in Northwest Texas.

GENERAL BLOWER CO. has named **Robert McAndrews** Cincinnati, Ohio, sales agent. McAndrews has been a manufacturers' representative in the Cincinnati area since 1940.

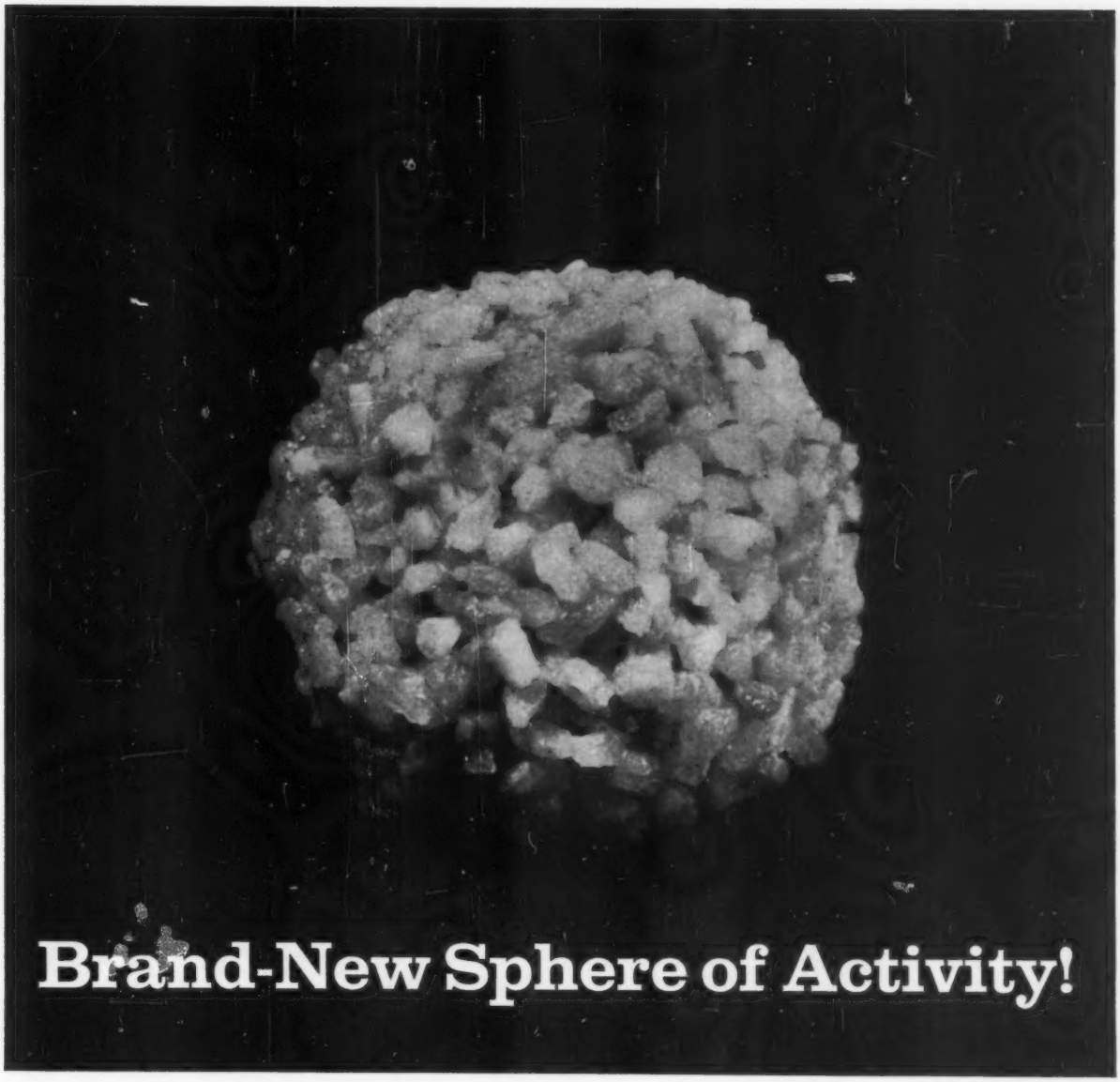
BAILEY METER CO. has elected **H. H. Gorrie** executive vice president; **L. F. Richardson,** vice president in charge of sales and a member of the board; and **J. H. Dennis,** vice president in charge of all manufacturing activities and plants. Gorrie joined the company in 1927 as an engineer. Richardson came to the firm in 1930, and Dennis joined Bailey Meter in 1937. Bailey Meter's headquarters are in Cleveland, Ohio.

Gorrie

Richardson

Dennis

GROVE VALVE AND REGULATOR CO., subsidiary of Walworth Co., has named **Frank F. Ross** and **I. M. Dearing, Jr.,**



Brand-New Sphere of Activity!

Here is a MACROPORT* "A" aluminum oxide sphere — Norton Company's newest development in catalyst carriers shown enlarged. Note its extremely porous structure, specifically designed to promote *faster, more precisely controlled* gaseous reactions. Pores are much larger than those in other Norton catalyst carriers, permitting gases to enter and diffuse readily, yet providing sufficient restriction for optimum control.

MACROPORT "A" catalyst carriers are currently available as spheres, pellets, and aggregate of fused aluminum oxide in the same price ranges as standard Norton carriers. A research program is now underway in the Norton laboratories to develop MACROPORT carriers in other materials.

For better yields from *your* reactors and improved process economy, get complete details on Norton MACROPORT "A" carriers. Write NORTON COMPANY, Refractories Division, 465 New Bond Street, Worcester 6, Massachusetts.

TYPICAL PHYSICAL PROPERTIES

	MACROPORT "A" 5/16"-3/8" Spheres	Aggregate (3-5 Mesh)
Apparent Porosity %	44-48	40-44
H_2O Absorption %	22-26	18-22
App. Sp. Gravity g/cc	3.4-3.6	3.4-3.6
Bulk Density g/cc	1.8-2.0	2.0-2.2
Packing Density lbs./ft³	63-67	68-72
Pore Dia. Range	50-200 Microns	50-200 Microns

*Trademark

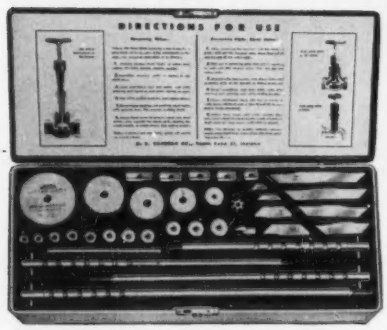
NORTON
REFRACTORIES
Engineered... Rx ...Prescribed

75 years of . . . Making better products . . . to make your products better

NORTON PRODUCTS: Abrasives • Grinding Wheels • Machine Tools • Refractories • Electro-Chemicals — **BEHR-MANNING DIVISION:** Coated Abrasives • Sharpening Stones • Pressure-Sensitive Tapes

For more data on advertised products, use cards, last page.

RESEATS VALVES and BIBBS QUICKLY ECONOMICALLY



Easily pays for itself on the first two jobs!

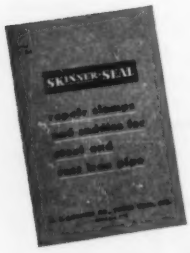
Reseats flat and tapered-seat globe or angle valves—all bibbs and faucets—in place, quickly and accurately. The saving, over tearing out and renewing leaky valves and fixtures, is tremendous.

Cutters operating under screw feed, leave worn, scored seats glass-smooth, level, absolutely accurate and tight.

A guide pilot centers each cutter; a tapered cone centers each spindle. Perfect alignment is inevitable. Cutters guaranteed. Write for literature!

2" for ¼" to 2" valves and ¼" to ¾" bibbs
List price $59.85

3" for ¼" to 3" valves and ¼" to ¾" bibbs
List price $79.50



FREE catalog showing our pipe repair clamps, saddles, and reseating tools

M. B. SKINNER CO.
SOUTH BEND 21, INDIANA

Suppliers . . .

sales engineers. Ross was division sales representative for National Supply Co. before joining Grove. Dearing was with Oil Center Tool Co.

REPUBLIC FLOW METERS CO., subsidiary of Rockwell Manufacturing Co., has appointed **Orval W. Riggs** manager of instrument and control product sales. Riggs will also handle sales for Republic Flow Meters Canada, Ltd. He was headquarters sales administration manager for Republic. He joined the company in 1956 after serving as vice president of sales for Hays Corp. and vice president and general manager, Thermco Instrument Corp.

Riggs

JOHNSON-WILLIAMS, INC., has appointed **E. L. Bruce** sales manager. Bruce joined Johnson-Williams, a Palo Alto, Calif., electronic firm, in 1959. He was previously district manager for C F Braun & Co., San Francisco.

CHICAGO BRIDGE & IRON CO. has transferred **W. Howard Boessneck** to its New York district sales office, **Donald E. Weinmann** to the Tulsa district office and **Leonard T. Kern, Jr.,** to the International Division headquarters in New York. All of the men were formerly assigned to CB&I's General Sales Department in Chicago.

RALPH N. BRODIE CO. has appointed **E. R. Bjornestad** Southwest Division manager in Dallas, Texas. Bjornestad will direct sales for meters and valves in Texas, Oklahoma, Louisiana, Arkansas and Tennessee.

NATIONAL LEAD CO. has elected **Graham W. Corddry** and **Claude M. Merrell** vice presidents. Corddry, director and member of the executive committee, is manager, Titanium Division. Merrell heads National Lead's foreign operations. Both men joined the company in the 1930's.

COMPUDYNE CORP. has named **G. R. Archer** general manager, Process Control Division, Hatboro, Pa. Archer was with Budd Co. as chief engineer, Electronic control section.

DATEX CORP. has appointed **Robert G. Parks** senior project engineer. He will head the heavy industrial systems group. Parks was formerly engineering manager of Neff Instruments Co.

SCIENTIFIC DESIGN CO., INC., has named **Theodore Q. Eliot** sales liaison engineer, Project Evaluation Department. Eliot has been manager, process development, Texas Butadiene & Chemical Corp.

ROCKWELL-STANDARD CORP. has elected **Harry Fante** and **F. W. Parker, Jr.,** executive vice presidents. Both men had been vice presidents in the corporation.

GENERAL MILLS CO.'s Chemical Division has promoted **Richard E. Moberg** to branch manager, West Coast area offices, Whittier, Calif. He has been with the company seven years. **Charles E. Pratt** has been named branch manager, Charlotte, N. C., office, supervising sales in the southeastern states.

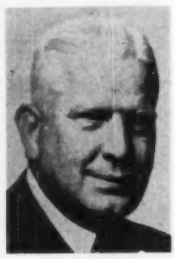
TUBE DISTRIBUTORS CO., INC., has named **John P. Barrett** manager, Special Products Division. Barrett came to Tube Distributors three years ago as a sales engineer for the New England territory.

BROWN FINTUBE CO. has named **Roger Amidon** chief coordinator. **Richard Holland** has been promoted to chief estimator. Amidon has been with the firm for the past nine years. Holland joined Brown Fintube in 1955.

GAS ATMOSPHERES, INC., has named **Emery M. Newton** sales manager. Newton came to Gas Atmospheres from the Pure Carbonic Division, Air Reduction, Inc.

SYMINGTON WAYNE CORP. has elected **F. L. Bredimus** vice president, sales, and **C. H. Godschall** vice president, manufacturing. Bredimus will manage sales for

Bredimus



Godschall

the corporation's nine divisions and subsidiaries in the United States and Canada. Godschall will head the firm's manufacturing operations in North America.

CAMBRIDGE WIRE CLOTH CO. has appointed **Olney P. Ross** manager, Conveyor Belt Sales Department. **Joseph E. McKnett**

REFRACTORY HAYDITE

Makes Higher Heat Resistant Concrete

Haydite aggregate used with Lumnite cement produces refractory concrete suitable for sustained temperatures up to 1800-2000° F., which makes it excellent for tubular heaters, ducts, flues, stacks and catalytic crackers. Weighing from 30 to 40 per cent less than ordinary aggregate concrete, Haydite is exceedingly strong. It has excellent insulating properties and withstands pressures of up to 1130 pounds per square inch. Write today for free folder and complete information about Carter-Waters Refractory Haydite.
We sell direct to you.

CONSTRUCTION MATERIALS
CARTER-WATERS
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THE TWO OUTSTANDING

PLATINUM REFORMING CATALYSTS

ENGELHARD
INDUSTRIES, INC.
CHEMICAL DIVISION
113 ASTOR STREET · NEWARK 2 NEW JERSEY

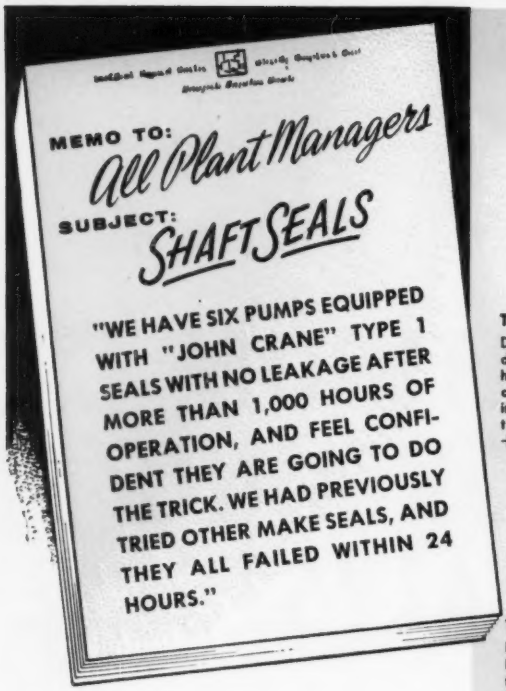
IMPORTANT NOTICE:

These two well established platinum reforming catalysts having distinctive product distribution patterns are now manufactured by Engelhard and supplied under a single license and catalyst supply contract. This new, singular service advantage allows you to choose the catalyst best suited to particular processing or economic conditions in a given installation. Greater latitude in reforming results thus assures maximum economy in each individual refining operation.

Investigate the unique performance of these outstanding platinum reforming catalysts. They provide longest periods of operation — *regeneration in situ!* They deliver important yield increases at high octane levels — *in existing equipment!* They reduce costs sharply—*to lowest level!*

An Engelhard representative will be glad to give you detailed information upon request. ★ ★ ★

PROMPT PRECIOUS METAL SCRAP RECOVERY SERVICE • ENGELHARD PROCEDURES RECOVER 100% OF ASSAYED PRECIOUS METAL CONTENT • IRVINGTON-BAKER REFINING DIVISION


MEMO TO:
All Plant Managers
SUBJECT:
SHAFT SEALS
"WE HAVE SIX PUMPS EQUIPPED WITH "JOHN CRANE" TYPE 1 SEALS WITH NO LEAKAGE AFTER MORE THAN 1,000 HOURS OF OPERATION, AND FEEL CONFIDENT THEY ARE GOING TO DO THE TRICK. WE HAD PREVIOUSLY TRIED OTHER MAKE SEALS, AND THEY ALL FAILED WITHIN 24 HOURS."

This is part of an actual memo sent by one plant manager to others of the same company in different sections of the country—and that company is now exclusively specifying these and other type "John Crane" Shaft Seals for *all* their liquid handling requirements.

You too can save time, trouble and expense by doing likewise.

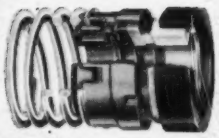
You'll find a "John Crane" Shaft Seal for every service . . . from hot or cold water to the most destructive acids and corrosives . . . high temperatures, high pressures . . . in types and sizes to meet practically any mechanical or dimensional requirement.

Send us details on your application. We'll recommend the proper shaft seal. Request Bulletin S-204-3 for complete overall information.

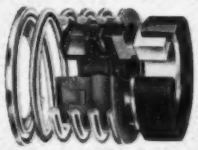
Crane Packing Co., 6420 Oakton St., Morton Grove, Illinois, (Chicago Suburb).

In Canada: Crane Packing Company, Ltd., Hamilton, Ont.

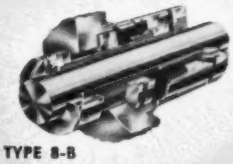
John Crane®



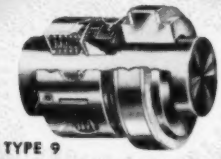
TYPE 1
Designed for limited stuffing box diameter. Handles water, light hydrocarbons, refrigerants, mild acids and other liquids non-injurious to synthetic rubber at temperatures from −40°F. to +212°F., pressures to 200 psi.



TYPE 2
Designed for limited stuffing box length. Handles same services, temperatures and pressures as Type 1.



TYPE 8-B
Heavy duty, high pressures. Packaged construction for easy installation. Handles pressures to 1200 psi., temperatures from −40°F. to +250°F. Services same as Type 1.



TYPE 9
Famous as a problem solver. Sealing members of chemically inert Du Pont Teflon. Engineered to service conditions to handle practically all destructive acids, corrosives and gases at temperatures from −120°F. to +500°F., pressures to 150 psi. Available in balanced construction for pressures to 750 psi.

Suppliers . . .

has been named head, Wire Cloth Department. Ross joined the firm in 1939, and McKnett came to Cambridge in 1951.

DASHEW BUSINESS MACHINES, INC., has elected **John H. Humphrey** executive vice president. Humphrey joined Dashew as vice president of management engineering and planning in August 1960.

WESTINGHOUSE ELECTRIC CORP. has appointed **Verne O. Clements** assistant to the vice president. Clements will handle apparatus sales to the petroleum and chemical industry in the southwestern sales region.

NALCO CHEMICAL CO. has promoted **R. E. Eddy, Orell Collins** and **P. M. Henry** to

Eddy

Collins

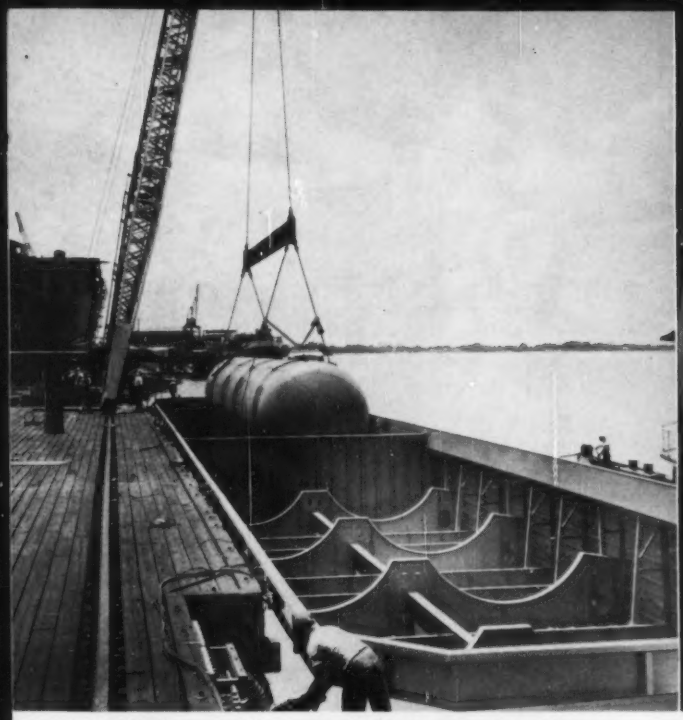
Henry

Industrial Division district managers. Eddy takes over the southeastern district with headquarters in Jacksonville, Fla.; Collins heads the South Atlantic district, and Henry becomes manager, mid-south district. Nalco Chemical is a Chicago-based manufacturer of water conditioning, petroleum treating and other industrial chemicals.

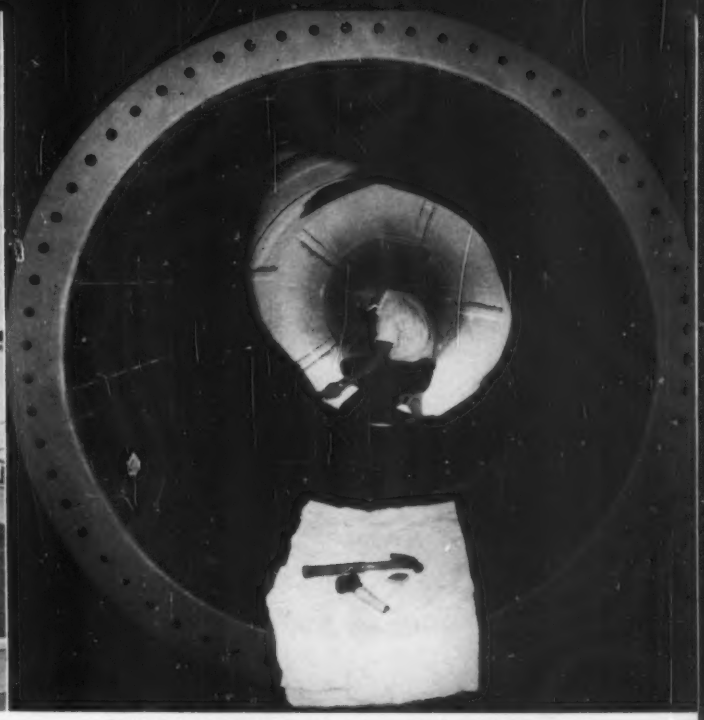
AMERICAN GILSONITE CO. has named **John H. Henderson, Jr.,** Salt Lake City, manager of engineering and product development. Henderson will direct new product development and will continue in charge of engineering and construction projects which he has handled for the past two years.

COMPUTER SYSTEMS, INC., producer of precision electronic analog computers, has assigned **Louis J. Pfeiffer** to the applications engineering staff. Pfeiffer will headquarter at CSI's Monmouth Junction, N. J., laboratory.

GOW-MAC INSTRUMENT CO., Madison, N. J., has elected **Alexander E. Lawson, Jr.,** vice president. Prior to joining Gow-Mac, Lawson was chief engineer of Fenwal Electronics, Inc., and general manager, Davis Instruments Co. Gow-



165,000 gallon capacity cargo tank being lowered into saddles in petrochemical barge hull. Lifting device (partly shown) has 600 ton capacity.



Rubber lining being applied to unit of a chlorine system. Flow meters, valves and tanks are lined with speed and efficiency. Avondale is the authorized U.S. Rubber Co. applicator for N.W. Fla., Ala., Miss., S.W. Tenn., Ark., and La.

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BUILDS and DELIVERS

THE MACHINERY OF PETROCHEMISTRY

From giant tank carrier barges to the smallest anticorrosive rubber lining job, Avondale builds and delivers the machinery of petrochemistry. Specialized engineering ability, shop facilities and fabrication skills assure custom construction to *your* specifications—Avondale is continuously aware of the special requirements of the petrochemical industry. And Avondale's strategic location permits fast delivery by truck, rail or barge.

Contact Avondale today about your next project. Use our skills and ability to *your* advantage.

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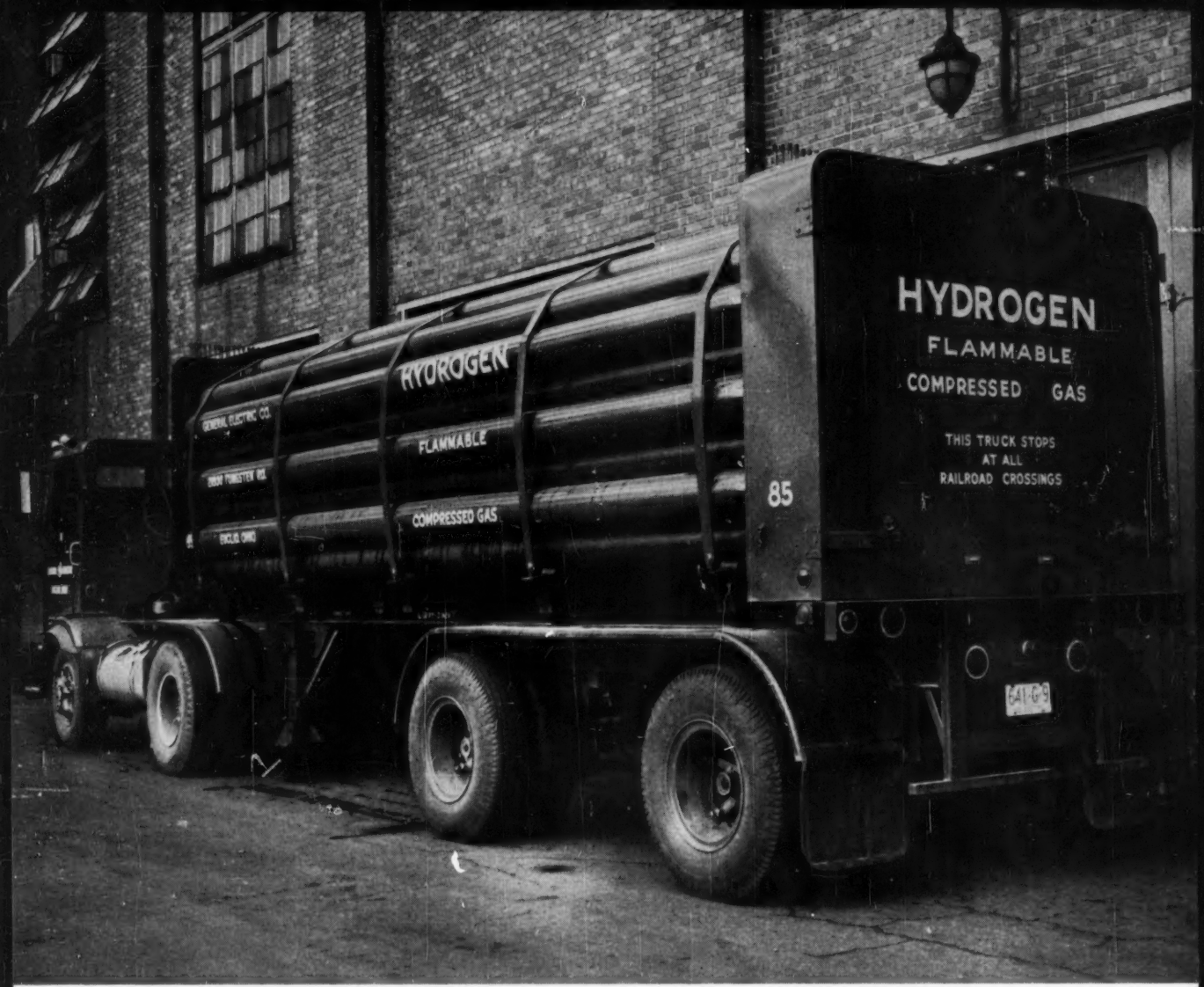
Weather and corrosion-resistant fire hose house. The Avoncraft Division produces these and other porcelain enamel on steel products including lagging and buildings of all descriptions.

Ethylene storage tank for a large chemical company, shipped by rail. Avondale fabricates pressure vessels and storage tanks in the Main Yard, the strategic location of which permits delivery by truck, rail or barge.



General Electric Company is one of the many big names in American industry which has adopted Taylor-Wharton Gas Transports as their means of transporting industrial gases.

Low initial *cost* and extreme *mobility!* — an efficiency and economy that can be found in no other means of distributing industrial gases!

Many other of the nation's gas producing, oil refining, petrochemical, food and electronic companies now employ flexible, mobile gas transports.

Why don't you? Write to:

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Division of HARSCO CORPORATION
HARRISBURG 2, PENNSYLVANIA

Suppliers . . .

Mac makes gas analysis instruments and thermal conductivity cells.

HENRY VOGT MACHINE CO., Louisville, Ky., has assigned **Edwin L. Kinkaide** to its Valve and Fittings Sales Division, New York office. He was formerly with Ohio Injector Co.

ALPHA-MOLYKOTE CORP., Stamford, Conn., has appointed **John R. Jones** manager of new product development. Jones was with Boeing Airplane Co. prior to joining Alpha-Molykote.

BOSTON WOVEN HOSE & RUBBER DIVISION, American Biltrite Rubber Co., has appointed Meissner Industrial Supplies, Inc., Wichita Falls, Texas, a distributor.

NEWPORT INDUSTRIES DIVISION, Heyden Newport Chemical Corp., has promoted **Theodore H. Risch** to general sales manager. Risch, who has been with Heyden Newport 14 years, was formerly field sales manager, Heyden Chemical Division.

CHICAGO PNEUMATIC TOOL CO. has elected **Donald N. McDonnell,** senior vice president of Blyth and Co., to its board of directors. McDonnell replaces **N. P. Hallowell,** who has died.

COOPER-BESSEMER CORP. has promoted **R. J. Graham** to sales engineer in the Mount Vernon branch sales office of the east-central sales district. Graham came to Cooper-Bessemer as a sales engineer trainee in 1958.

J. I. CASE CO. has appointed **S. F. Brock** manager of product education and sales training. Brock has been with the company for 12 years.

PERKIN-ELMER CORP. has named **John C. Stick, Jr.,** general manager, Instrument Division. Before joining Perkin-Elmer, Stick was with Lane-Wells Co.

HOOVER BALL AND BEARING CO., Ann Arbor, Mich., has transferred **James Veras** from the Hoover Bearing Division to the Cuyahoga Steel and Wire Co., a Maple Heights, Ohio, division. Veras has been director of materials at the Hoover Bearing Division.

ARMSTRONG CONTRACTING AND SUPPLY CORP. has elected **J. S. Taylor** and **A. P. Tingle** vice presidents. Taylor was district manager in the firm's Atlanta office, and Tingle served as district manager in New York.

CONTINENTAL-EMSCO CO. has opened a new supply store in Hennessey, Okla. **Bob Hull** is manager of the facility.

WORTHINGTON CORP. has appointed **Lewis M. Evans,** Upper Montclair, N. J., eastern regional resale sales manager, Marketing Division. He will sell compressors, pumps and mechanical power transmis-

S&J savings protection

You can be sure that accuracy and reliability are always built into Shand & Jurs designed liquid level **GAGES.** Designed by engineers who **know** what you require. S&J offers the industry precision gages with easy-to-read digital indication, vapor-tight construction and freedom from maintenance—all contributing toward savings and protection for your plant and personnel. You will also be interested in S&J

2006

BREATHER VALVES that will give you the minimum maintenance service that you need for true operating economy. Unique construction assures tight seating for vapor savings, and excellent resistance to sticking, corrosion and freezing—a major achievement in tank protection. Be sure to see the latest development in safety, too: examine the S&J

4009

DEPRESSURING VALVE that affords emergency venting as outlined in API RP-520. Self-energized and fail-safe, it can be either manually or automatically actuated to dump hazardous pressures during exposure fires, for the ultimate in safety. It can be rapidly re-closed on command, for obvious product savings. S&J proudly offers you

4280

RATE which combines continuous alarm scan with telemetering and supervisory control. Utilizing solid state electronics, RATE provides speed, flexibility, reliability and savings throughout! And it operates over a single low-grade, low-cost communications channel. You are protected by complete error-checking of all addresses and inputs. Automation of tomorrow—today!

RATE

Detailed specs on any S&J product are available to you. Your inquiry will receive prompt attention. Write today.

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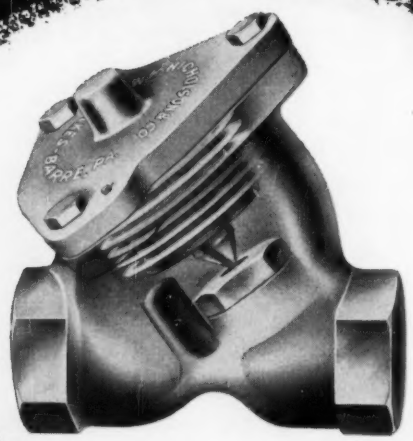
A NEW DEVELOPMENT

FOR STEAM-SAVING EFFICIENCY



Nicholson Thermostatic Steam Trap Model N-150

- ALL STEEL CONSTRUCTION
- JUST ONE WORKING PART
- RUGGED MONEL BELLOWS
- NEW BAFFLE* . . . deflects steam upward and away from the orifice to surround the bellows
- FREEZE PROOF WHEN INSTALLED VERTICALLY
- CAN BE TESTED AND INSPECTED WITHOUT BREAKING PIPE CONNECTIONS
- COMPACT, LIGHTWEIGHT, EASY TO INSTALL
- FOR TRACER LINES also Plating Tanks Platen Presses • Unit Heaters • Sterilizers and various types of Cooking and Laundry Equipment. N-150 Traps can also be used as air vents for Receivers, Water Heaters, Mechanical Traps, etc.

Our 80th Year

- W. H. NICHOLSON AND CO.
12 Oregon St., Wilkes-Barre, Pa.

* Patent applied for

Suppliers . . .

sion equipment in the firm's district office territories of Boston, New York, Philadelphia and Washington, D. C.

ROCKWELL MANUFACTURING CO. has appointed **Thomas J. Williams** branch manager, El Paso, Texas, office. He will handle meter and valve sales in West Texas and Southern New Mexico. Williams joined Rockwell in 1954 as a sales engineer in the Tulsa district.

BLACK, SIVALLS & BRYSON, INC., has announced the death of its executive vice president, **Henry A. Ruysser, Jr.,** 56. Ruysser, a native of Kansas City, Mo., died March 29. He had been a vice president and a member of the board of directors for the company since 1946. He was elected executive vice president in 1955. Before joining BS&B, Ruysser was a partner in Smith Engineering Co., Kansas City, from 1944 to 1946. He was a member of the Petroleum Equipment Suppliers Association, National Sales Executives, American Management Association and the Oklahoma City Chamber of Commerce.

Ruysser

CONSOLIDATED ELECTRODYNAMICS CORP., Analytical & Control Division, has placed **S. W. (Whit) Downer III** in charge of sales in the New York area through offices in Hasbrouck Heights, N. J. **John A. Shaffer** will succeed Downer as Dallas sales office manager.

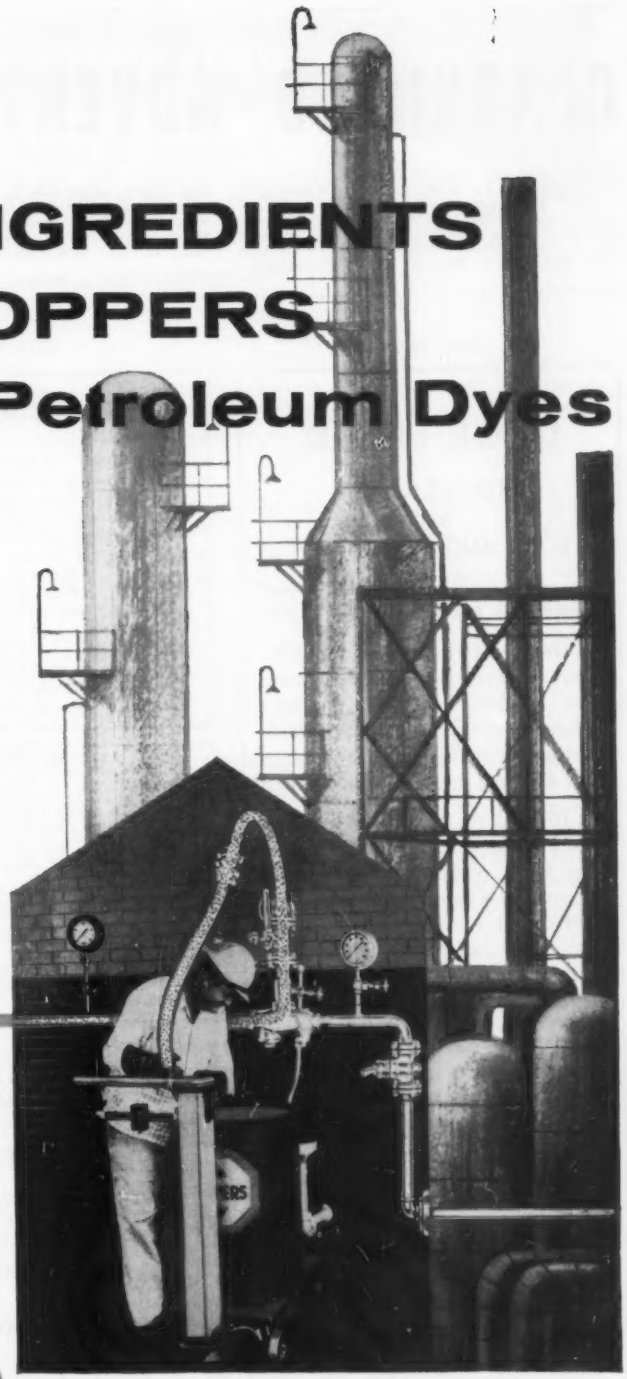
RESISTOFLEX CORP. has appointed **Richard T. Dale** works manager. Dale, who joined the company 11 years ago, has been assistant to the executive vice president.

DE LAVAL SEPARATOR CO.'s Industrial Division has named **Hugh J. McNelis** sales engineer in the Philadelphia office. Before joining De Laval, McNelis was with Simplex Valve & Meter Co.

AMERICAN POTASH & CHEMICAL CORP. has assigned **Leonard L. Lyle** to the Shreveport, La., district office as sales representative. Lyle, a graduate of Louisiana Polytechnic Institute, was formerly with Westinghouse Electric Supply Co.

DEUTSCHE NALCO-CHEMIE G.m.b.H., German subsidiary of Nalco Chemical Co., has named **Wolfgang Kreuder** manager. Kreuder will headquarter in Frankfurt, West Germany, 10 miles west of the Nalco manufacturing plant at Dornigheim. He was previously with Esso, A.G., German affiliate of Standard Oil Co. (New Jersey).

PLUS INGREDIENTS in KOPPERS Gran-U-Flow™ Petroleum Dyes



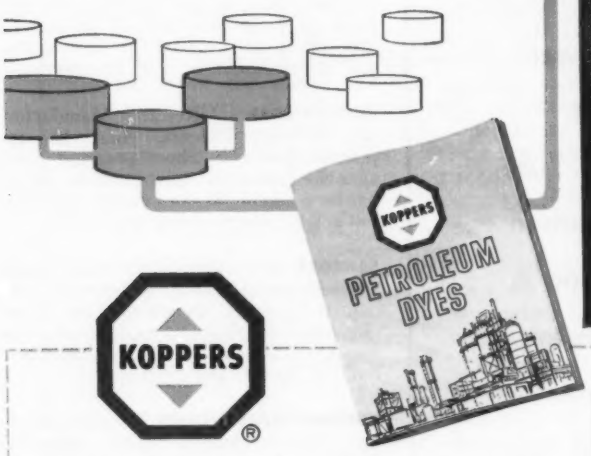
There *are* PLUS INGREDIENTS . . . in Koppers Gran-U-Flow Dyes . . . extra reasons why you should specify Koppers:

- unvarying uniformity . . . batch-to-batch
- high tinctorial strength
- dustless
- low benzene insolubles
- high solubility
- granular (Gran-U-Flow) . . . for *easy* flow

Whether you use petroleum dyes for gasoline, anti-freeze or a wide range of lubricants . . . for corporate identity, improvement of product appearance or ease of identification . . . you owe it to yourself to investigate the superior advantages of Koppers Gran-U-Flow Dyes.

Dye drums are color coded and designed for eductor systems in refineries.

Clip the coupon below to your company letterhead for a booklet showing newest eductor techniques. A free laboratory kit is also available. VMA 6982



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Chemicals and Dyestuffs Division

KOPPERS BUILDING, PITTSBURGH 19, PA. • **Plant:** Lock Haven, Pa.
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☐ Please send booklet on newest eductor techniques.

☐ Please send free laboratory kit for Gran-U-Flow Petroleum Dyes.

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CLIP TO YOUR COMPANY LETTERHEAD.
Mail to our Pittsburgh office or nearest branch.

For more data on advertised products, use cards, last page.

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RATES: **Regular Classified** (undisplayed) set in this type: 20 cents per word. Minimum charge, $4. Blind box address in our care counts six words. Replies forwarded without charge. **Display Classified ads,** set in suitably larger type with ruled border $13.50 per column inch. Ten percent discount for two or more insertions of same copy in consecutive issues. **All Classified ads payable in advance.** Copy dead line 25th of month preceding date of issue. Send copy and checks to: Classified Advertising, Hydrocarbon Processing & Petroleum Refiner, P. O. Box 2608, Houston, Texas.

HELP WANTED

CHEMICAL ENGINEERS

PROCESS DESIGN AND ECONOMIC EVALUATION

Do you want to take part in developing New Processes - New Units?

Our group has played a key part in developing new processes for synthetic rubbers, plastics, high-octane HF Alkylate and many others. We prepare designs for Phillips licensees world-wide.

If you hold a degree in Chemical Engineering and have two to six years' experience in Petrochemical, Chemical, Plastics or Petroleum Refining Fields, you, too, can participate in an expanding R & D program in this growth-minded Company.

Write to:

Personnel Procurement
Research and Development Department
PHILLIPS PETROLEUM COMPANY
Bartlesville, Oklahoma

Computation Programming Refinery Economics

Our Refinery Technology Division needs men qualified to:

1. **Conduct studies of Refinery Economics, using modern computing and mathematical methods, and**
2. **Develop Computer Programs (IBM 1620, 7090) in support of Refining Economics, Fuel Blending, and Statistical Analysis of Fuel Performance Data.**

These professional positions in a technical-consulting activity offer and require a high level of individual responsibility. Projects vary widely and contribute directly to sales effort.

Located in a suburb of Detroit, the division supports Field-Technical Personnel covering U.S., Canada, Mexico and Export.

Send resume to:

Personnel Manager
ETHYL CORPORATION
1600 West Eight Mile Road,
Ferndale 20, Michigan

WANTED

Manuscripts Wanted

Have you written a book you would like to have published? Do you have an idea or an outline that you would like to talk over with a publisher? Gulf Publishing Company, publishers of World Oil, Hydrocarbon Processing & Petroleum Refiner and Pipe Line Industry magazines, and numerous technical books, is actively seeking trade and technical manuscripts for publication by its rapidly expanding Book Division. For further information write to Manager, Book Publishing, Gulf Publishing Company, P. O. Box 2608, Houston 1, Texas.

FURNACE REQUIRED

We are seeking 2 Born Horizontal or equivalent, 2½ million to 5 million, and 5 million to 12 million b.t.u. duty furnaces, with rolled tubes and header boxes.

Please quote description, age, model, condition, price and location.

C. Parsley, Mgr., 5830 Carthage Avenue, Cincinnati 12, Ohio or Phone ME-1-6179.

You may also quote on a vertical unit, although horizontal is preferred.

- REPRESENTATION WANTED new unit control valve, barstock valves. Sensational savings for continuous processing service. Exclusive franchised distributorships available. Box 353-R, PETROLEUM REFINER, Houston, Texas.

If you want *fast* results . . . use Hydrocarbon Processing & Petroleum Refiner classified ads. They don't cost, they pay.

Suppliers . . .

UNITED STATES RUBBER CO. has assigned **Douglas M. Smith** marketing manager of the Mechanical Goods Division. Smith was formerly eastern regional sales manager of the division.

CRUCIBLE STEEL CO. OF AMERICA has appointed **Robert M. Simpson** assistant director of sales. Simpson, who joined the firm in 1940, was assistant general manager, field sales.

CHANCE VOUGHT CORP. has named **Joe Ehrenberger** senior market analyst in the Electronics Division. He will headquarter in Dallas. Ehrenberger was formerly sales analyst for the Dallas district office of American Standard Plumbing and Heating Division.

HENRY PRATT CO., Chicago, has appointed Dean Engwall Co. manufacturer's representative covering Oklahoma and part of Arkansas. Henery Pratt makes rubber seat butterfly valves, rubber seat ball valves and fabricated steel products.

INFORMATION SYSTEMS, INC., has changed the name of its Computer Division to Systems Division. Division headquarters are in Los Angeles.

HAGAN CHEMICALS & CONTROLS, INC., has named **Aaron Waxman** West Coast regional sales manager for the Controls Division. Waxman will be in charge of sales in California, Arizona, Nevada, Oregon, Washington, and Northern Idaho. He joined Hagan in 1952 as a sales engineer.

LASCO ENGINEERING CO., a Tulsa consulting firm, has elected **Jack T. Lindsey** vice president. Lindsay, who joined Lasco in June 1960, as general manager, will head the Petroleum Division which handles plant and special product design and development as well as appraisals.

GARRETT CORP.'s AiResearch Manufacturing Division, Phoenix, Ariz., has appointed **James T. Shore** program manager for industrial gas turbines. Shore has been serving as sales engineer in Garrett's Fort Worth office since 1959.

SANBORN CO., makers of electronic measurement and recording instruments, has named **George F. Benoit** director of engineering. Benoit comes to Sanborn from Raytheon Co., where he was manager, Surface Radar Department.

CORNING GLASS WORKS' Technical Products Division has promoted **John M. DeMunn, Jr.,** to supervisor of customer service for the eastern sales district. De Munn, who will be headquartered in New York, joined the firm in 1949.

AIR REDUCTION SALES CO. has appointed **J. W. Cunningham** manager of the Pittsburgh, Pa., district sales office. He has been with Airco since 1947.

JEFFERSON GAS TREATING BRIEFS

You Should Have A Planned
ETHANOLAMINE ANALYSIS PROGRAM

Any plant using ethanolamines for absorption of either hydrogen sulfide and/or carbon dioxide should periodically review their program of analysis. Each plant will vary in its ability to perform tests depending on the availability of laboratory equipment and experience of laboratory personnel. Large plants are usually able to handle a more comprehensive range of analyses on amine solutions than the smaller plants.

Analysis of plant amine solutions normally falls into three main categories: (1) routine, (2) periodic, or (3) special tests.

ROUTINE TESTS

There are several informative tests on amine solutions which can be performed with a minimum of laboratory equipment and experience by plant personnel. A visual examination of the solution for appearance, color, and insoluble matter can give important clues as to the operation of the solution filters, hydrocarbon contamination and metal salts which affect the color. Determination of free amine content by simple titration with hydrochloric acid is normally used on a routine basis to check the amine strength. Many plants process several different gas streams of varying acid gas content. These variations can produce significant changes in the acid gas loading of the amine solution. It is particularly helpful in such situations to routinely check the total acid gas loading of the rich amine solution. When acid gas loading of the amine solution exceeds recommended levels, it indicates the need of either increasing the amine strength or increasing the amine circulation rate. This prevents accelerated corrosion of heat exchangers and reboilers.

PERIODIC TESTS

The periodic analysis of amine solutions on some regular schedule is an excellent form of preventive maintenance. Trends of the physical condition of the solution indicate remedial action to be taken before serious operating problems are encountered.

Most of the troublesome compounds found during extensive examination of amine solutions are relatively non-volatile, for example, the various heat stable amine salts and degradation products. The cumulative effect of these compounds over extended periods of time can reach serious proportions. The advance knowledge that an undesirable component is accumulating in the solution allows time to take steps to reduce the contamination.

Tests for the amount of combined amine, nitrogenous degradation products, and acid gas contents of both the lean and rich amine solutions (as well as other contaminants known to be a problem) should be run on a schedule to suit the specific needs of each plant. The frequency of these analyses might be anywhere from weekly to semi-annually.

SPECIAL TESTS

The contamination of amine solutions by compounds carried in with the gas stream is not unusual. Typical of such sources of contamination are the introduction of excessive amounts of valve lubricants and compressor lubricating oils, organic acids, carbonyl sulfide and air leaks in gas gathering lines or process streams operating under reduced pressure.

When the source of contamination is not known, it is advisable to use some scheme of qualitative analysis to determine the nature of the compounds. Typical qualitative tests which might be run on a solution where an unusual problem exists are: thiosulfate, thiocyanate, sulfate, chloride, and sodium. Once this is done then quantitative analyses for the specific contaminants may be used to obtain more information regarding the degree of contamination. Tests for iron capacity and foaming tendency are useful tools for indicating the effects of contaminants on the amine solution.

Assistance in establishing a testing program tailored to your needs is available from Jefferson's Technical Service Laboratories in Austin, Texas. Help with problems requiring special analysis can also be supplied. The analytical results will be carefully evaluated and recommendations made for corrective action.

For complete information on Jefferson glycols, ethanolamines, and helpful technical services . . . contact Jefferson Chemical Company, Inc., 1121 Walker Avenue, P. O. Box 303, Houston 1, Texas.

HOUSTON • NEW YORK • CHICAGO • CLEVELAND
CHARLOTTE • LOS ANGELES • SAN FRANCISCO

JEFFERSON CHEMICALS

049

New Equipment & Literature...

as selected by Frank L. Evans, Jr., Mechanical Engineering Editor

"Flip-top" cover simplifies maintenance.

Storage Tank Breather Valve Is Freeze Resistant

A new, freeze-resistant "all-weather" breather valve has just completed a two-year field test on benzene tanks in Sidney, Nova Scotia. It performed perfectly under extreme weather conditions with a product that froze at between 36° and 38° F. In addition, the valve worked equally well during the hot, humid summer weather.

This new Varec breather valve uses, on both pressure and vacuum pallets, a flexible diaphragm of special non-frosting and icing-resistant material. This protects against the pallets freezing closed and assures vapor tightness under all types of weather conditions. In addition, a non-frosting and icing-resistant compound is applied to the pallet perimeter and stem, guide posts and tip of seat ring.

Inspection and maintenance have been simplified by a "flip-top" cover which is quickly released by twisting two spring-loaded release handles. Vapor Recovery Systems Co.

Circle E1 green card, last page

72 Combinations Possible With New Process Pumps

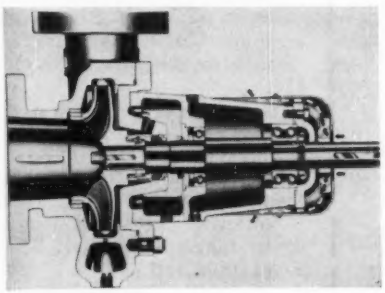
An entirely new line of standard process pumps offers the application flexibility of custom-engineered models.

From two basic pump types up to 72 basic combinations are possible. By interchanging impellers, covers, nozzle arrangements, bearing construction, cooling methods and other components, the requirements for almost any given service can be met from standard, off-the-shelf parts.

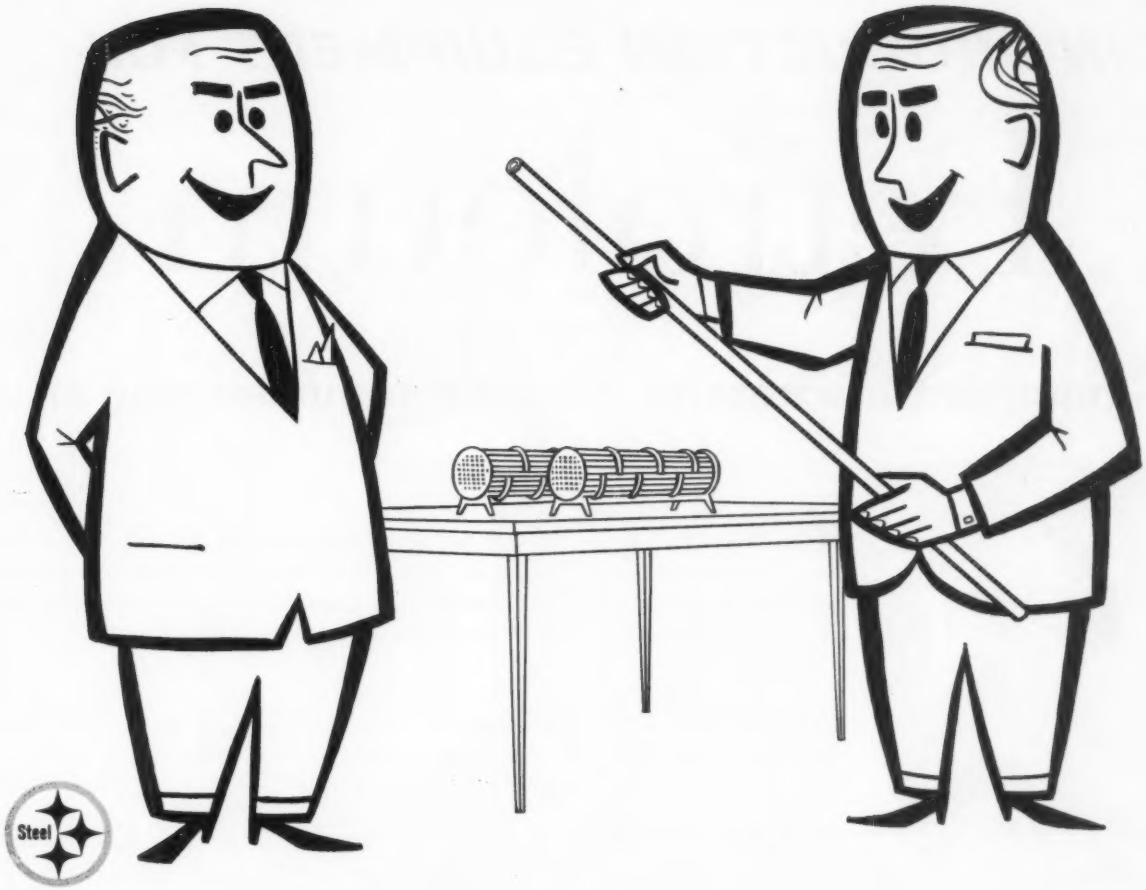
An additional benefit for plants with a number of different pump applications is the simplicity of stocking spare parts.

One of the important new design features of the line was developed around a long-existing need of the industry—an air-cooled bearing housing. Using a special built-in fan cooling system, it eliminates the need for a cooling water supply to the bearings in many applications, and provides further savings in both installation and operation.

Model SMJ is designed for high temperature service with either top or end suction. Vertically split with centerline-support mounting, it has a water-jacketed stuffingbox for either packing or a mechanical seal. Single or double-stage construction is offered, as well as single or double suction. Capacities are available to 1,200 gpm, differential heads to 1,600 feet, pressures to 1,000 psi, and temperatures to 850° F.



For lower temperature service, the SMJI is an internally sealed version of the SMJ, using a mechanical seal as standard construction. For use with



YOU GET LOWEST FINAL COST, OPTIMUM SERVICE LIFE

when you specify B&W Job-Matched Pressure Tubing

The cost saving dividends are greater—the design opportunities unlimited—when you make your selection from B&W's complete line of Job-Matched Pressure Tubing. To arrive at the tube that meets design as well as optimum cost requirements, you have a choice of seamless and welded in all grades and sizes of stainless, alloy or carbon steel. And when you need it, B&W provides the kind of unbiased assistance that only a full-line producer can give. Uniform dimensions, properties and steel quality are added values beyond standard specifications. As a result, B&W tubing saves on cost through easier fabrication, faster installation, greater operating efficiency and longer service life.

For a close look at final cost savings, contact your local B&W District Sales Office or write for Bulletin T-417. The Babcock & Wilcox Company, Tubular Products Division, Beaver Falls, Pennsylvania.

B&W

THE BABCOCK & WILCOX COMPANY

TUBULAR PRODUCTS DIVISION

TA-1004-P

Seamless and welded tubular products, solid extrusions, rolled rings, seamless welding fittings and forged steel flanges—in carbon, alloy and stainless steels and special metals

IN PRODUCTION EQUIPMENT FOR

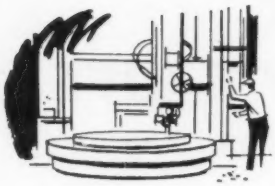
Petroleum

important progressive changes are under way at....

Research! Every product line from the Conaform dryers to the smallest mixing equipment is being thoroughly researched, and analyzed to produce a better piece of equipment for the lowest possible cost. Lower burden helps reduce your price, but better engineering is producing a better product.

Design! Experienced designers are busy creating a new look, a new form, a new serviceability in the Patterson Line of products for industry.

Mechanization! Thousands of dollars are being poured into new equipment, new facilities to enable Patterson to comfortably produce a mixer, a group of processing equipment, or an entire production facility. Before you buy, be sure to check the savings you'll get at Patterson.



Efficiency! New work standards, automatic machinery, new equipment means greater efficiency — better work flow — better delivery. The important changes under way at Patterson mean big savings and better processing equipment for you!

Yes, Patterson is rapidly becoming one of America's leading sources of processing equipment for the Petroleum industry. In every department men are busy with welding torches, milling machines, chip-removal machines, building the finest equipment possible at really great savings. *Regardless of your previous practices it will pay to discuss your program with Patterson's engineer-trained sales representatives.*

THE Patterson FOUNDRY AND MACHINE COMPANY
East Liverpool, Ohio, U. S. A.

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The Patterson Foundry and Machine Company, (Canada) Limited
Toronto, Canada — Montreal

THE PATTERSON GREASE KETTLE

In today's rapidly expanding production systems in both the petroleum and petrochemical fields, Patterson equipment is accepted as standard. The reason, is installations for grease kettles such as the one shown here have operated continuously for more than 20 years without loss of production time. Superb workmanship, highest quality materials, guarantees Patterson reliability. Check your requirements for all types of processing equipment with the man from Patterson!

TURN THE PAGE

FOR MORE INFORMATION

Patterson Foundry & Machine Company

Gentlemen:

*Please arrange to contact us about a*_____

_____

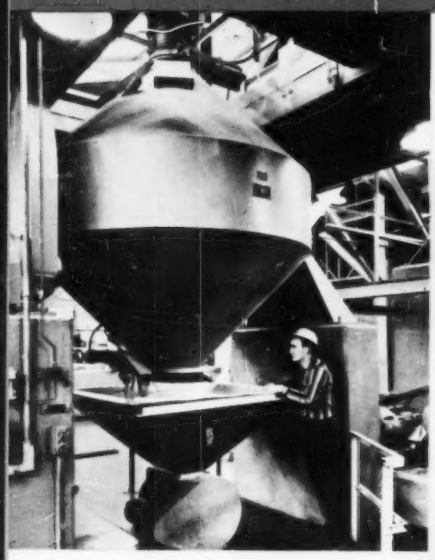
NAME_____

TITLE_____

COMPANY_____

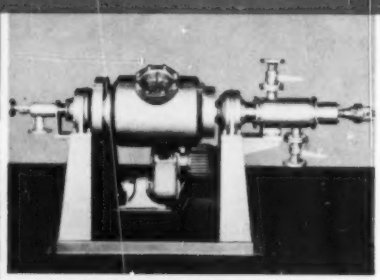
CITY_____ STATE_____

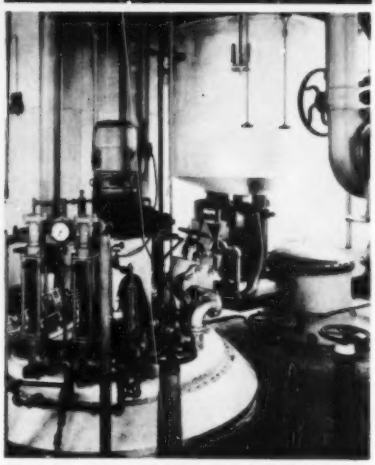
Current Production at Patterson FOUNDRY AND MACHINE COMPANY for the Petroleum Industry

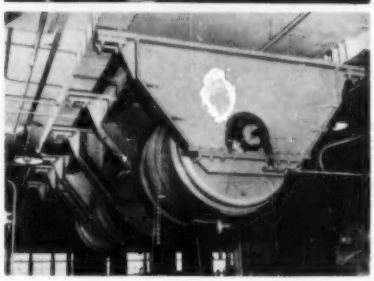


The Thoro Blender

This widely accepted unit has produced peak performance year after year because the design is correctly engineered to produce super-rapid gentle mixing of almost every conceivable material. The unit quickly produces an intimate, thoroughly homogeneous blend of materials even where the most difficult variations in particle size and densities are encountered. Check the Thoro Blender brochure for complete details.







Mil Reactor

A simple test in Patterson's pilot plant in the laboratory at East Liverpool, Ohio will convince you that this unit can save thousands of dollars on a single installation. It allows blending, dispersing, and wetting to be combined with reacting, drying, or grinding operations all in one unit. It is possible to gas-blanket, operate within precise temperature ranges, and in batches or continuous flow! One of Patterson's most valuable engineering contributions to the chemical processing industry is the amazing Mil Reactor.

Synthesizing System

Three Patterson resin systems are reported to result in greater accuracy, a reduction in material handling, and insure maximum safety in the production of acrylics, alkyds, epoxies, polyesters and many other polymers. A Patterson pilot plant is also in operation. Shown are reaction vessels typical of the kind of engineered systems for which Patterson has become so famous. Check Patterson for all systems and mixing, and grinding equipment.

Ball Mills

Ruggedly constructed, these mills are made with steel heads, accurately bored to receive the steel shells. Shafts or gudgeons are accurately machined; they are ground and polished. Main bearings are heavy duty, self-aligning, 100% oversized. Patterson ball mills are renowned the world over for their quality and dependable service. A complete brochure is available.

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BUSINESS REPLY MAIL
FIRST CLASS PERMIT NO. 22, EAST LIVERPOOL, OHIO

Patterson Foundry & Machine Company

East Liverpool, Ohio

MAIL INQUIRY TODAY

to express our thanks... the first 100 will receive a fine ball point pen with a draftsman point!

Litho in U.S.A.

temperatures to 400° F, all other capacities are the same as the SMJ models. Byron Jackson Pumps, Inc.

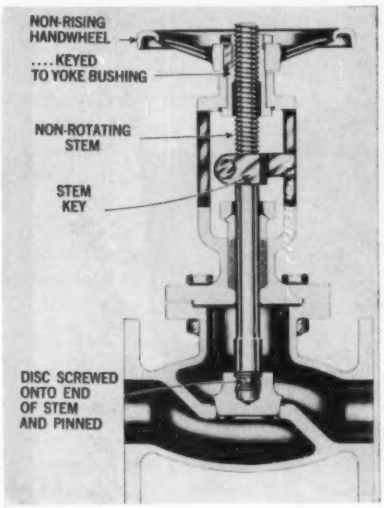
Circle E2 green card, last page

New Globe Valve Eliminates Disc Vibration and Chatter

A new concept in the design of globe-type valves promises to give closer throttling control and eliminate disc vibration and chatter.

The change consists of a redesign from the conventional valve having a rotating stem with rising handwheel and swivel disc to a valve having a non-rotating stem with a non-rising handwheel and fixed disc.

Because of this radical change three major disadvantages of conven-



tional globe valves, in 2-inch sizes and over, have been eliminated:

- Stem vibration and disc chatter are eliminated.
- Galling between the stem foot and disc is eliminated. When such galling occurred, the disc could turn into the seat, damaging the seat area and prventing tight closure.
- The tendency of the stem in the conventional design to cut a spiral through the packing, which can cause excess leakage, is quite costly and dangerous when handling corrosive fluids. This is eliminated in the new design because the stem does not turn in the packing. Alloy Steel Products Co.

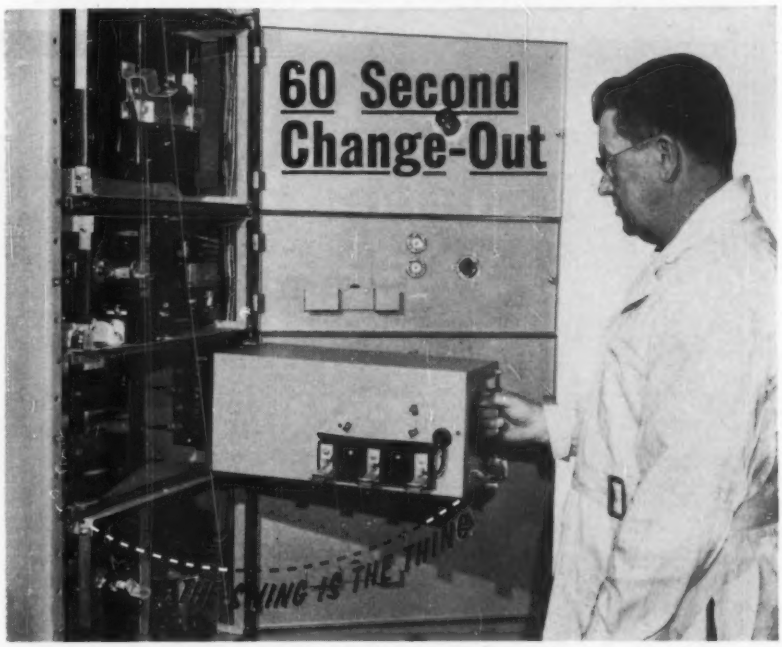
Circle E3 green card, last page

It's All NEW . . . In Concept In Application

Automatrol

► FROM NELSON

The First Motor Control Center Specifically Designed for use with Automated Systems



60-seconds or less is all the time required to change-out a starter or circuit breaker in the new Nelson AUTOMATROL motor control centers.

No tools, no specially trained personnel are required. You simply open the door, release the safety latch, swing the unit out and lift it off the pin hinges. You install the new unit just as easily. What could be more important when production is stopped?

This is only one of many new features found in Nelson AUTOMATROL motor control centers that are designed specifically for automation systems. For complete information write for Bulletin 2001 or call your local Nelson representative.

BIG ENOUGH TO PERFORM — SMALL ENOUGH TO CARE

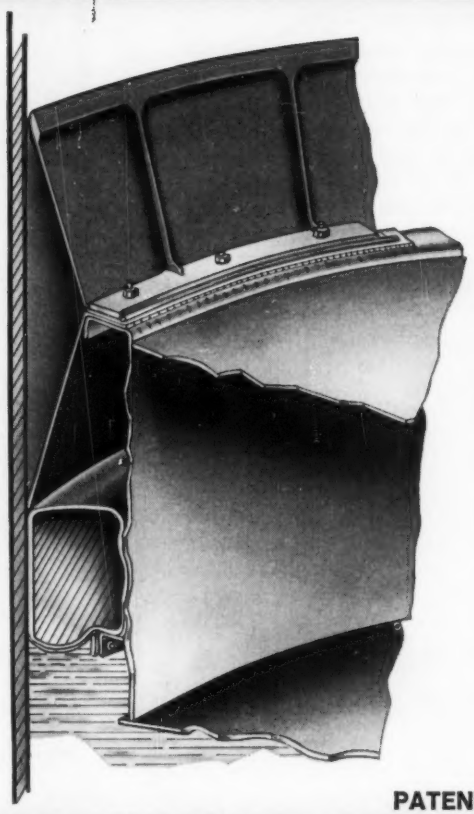
NELSON *Electric* MANUFACTURING CO.
TULSA, OKLAHOMA

P. O. BOX 5385 NATIONAL 7-5530

For more data on advertised products, use cards, last page.

ALL FLOATING ROOF TANKS ARE FULLY EQUIPPED, **BUT...**

Only Tubeseal Has Lightning-Proof, Electro-Conductive Weather Shield



PATENTED

Tubeseal electro-conductive weather shields are an *exclusive tried and proved development.* They provide positive protection against lightning-caused rim fires. ■ How? By maintaining a *continuous* grounding bond between roof deck and shell—concentration of static charges is impossible. There has *never* been a lightning fire where any of the many hundreds of Tubeseal System Floating Roof Tanks are installed throughout the world—they're "lightning proof." ■ This is scientific and safe storage protection for the entire range of volatile products. Tubeseals can be installed on any of your tanks—new, old, riveted, or welded. You owe it to the future safety of your conservation facilities to investigate. Send for the Tubeseal Bulletin now—it could be important.

PDM
FABRICATORS · CONTRACTORS

Pittsburgh-Des Moines Steel Company

12 plants to serve you coast to coast

HAMONDTANK

PITTSBURGH, WARREN, BRISTOL, PA. • BALTIMORE • BIRMINGHAM • DES MOINES
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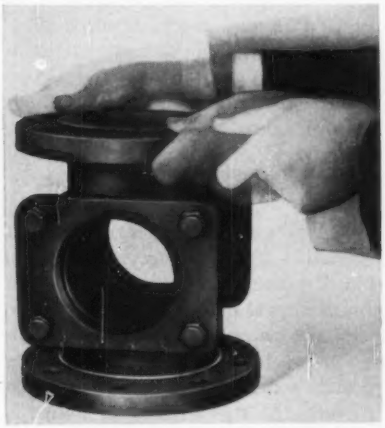
New Equipment . . .

Flow Indicators Eliminate Need for Blind Threads

The company's new flow indicators are designed to meet the requirements of the chemical processing industries—no blind threads. Flanged models fea-



ture rotatable split-ring flanges to allow precise positioning in pipe line for best viewing angle.

Pressure ratings to 500 psi, temperature ratings to 300° F.

Cast iron, steel, or stainless steel indicators, screwed or flanged, are stocked for prompt shipment. Brooks Instrument Co.

Circle E4 green card, last page

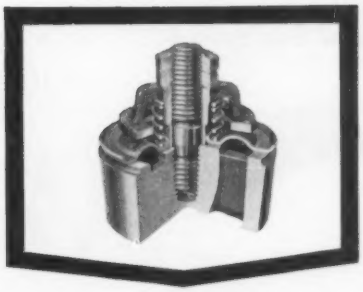
Tank Heaters Pass Through Standard API Manhole

The new Type KH-223 tank heaters weigh only 170 pounds and can be carried easily over the rough ground of a tank farm by only two men. The heaters will pass through a standard API 20-inch manhole and can be installed in new or existing tanks either singly or in banks.

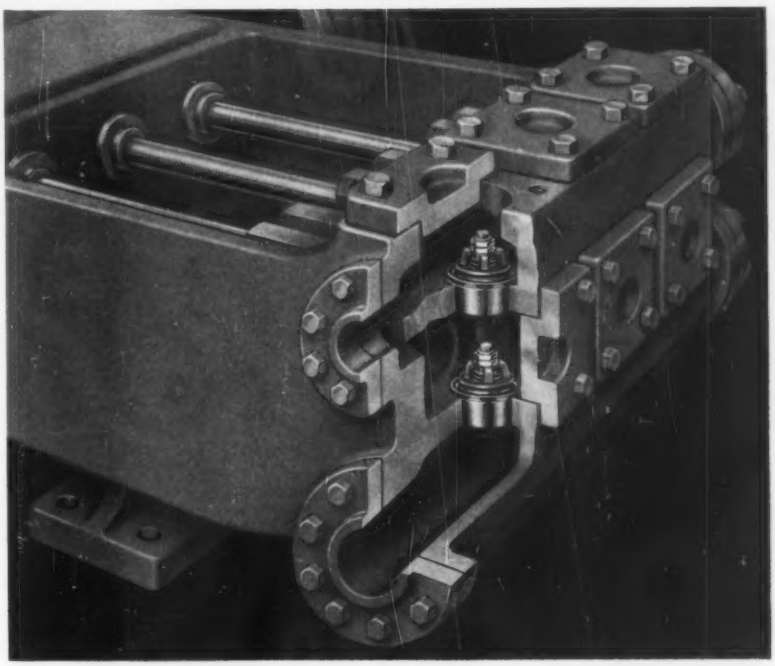
These heaters consist of two lengths of 1-inch IPS schedule 40-steel pipe with G-R service-proved helical aluminum "K" fins spaced six to an inch. The helical aluminum fins of heavy duty design, 5/8 inch high by .03 inch thick, are locked tightly into the pipe to assure good heat transfer. Since aluminum has a high coefficient of heat transfer—much higher than steel—the heaters have high heating capacity per foot of pipe length.

The two sections of the finned pipe are welded together to form one continuous length; then bent to form six passes; and supported in steel plates

fast valve action



points the way to high-speed pump efficiency



DURABLA Valves are ideally suited to modern high-speed reciprocating pumps. One big reason: Valve action is very sharp, thanks to a light-weight, free-moving member.

Formed from thin, non-corrosive metal, the valve member is designed to make but "point contact" on the sleeve. This unique feature, together with the patented arched design, makes it the freest moving and most durable valve available. Will never warp, bind or hang up.

Quick and easy inspection of working parts (without the necessity for stud or seat removal) is possible due to a self-locking nut and drop-on guard. The taper-lock stud can be screwed down tight into the seat without danger of galling or breakage . . . there is no excuse for overstressing no matter how many times it is removed and then returned to position.

A credit to new pumps, DURABLA Valve Units are also widely used to re-valve older pumps. Come in 15 sizes, designed to meet over 300 variations in installation requirements.

For full details, send for booklet PR 61.

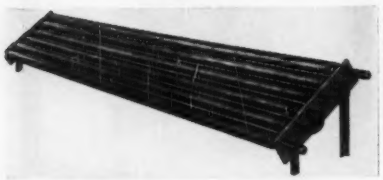
DURABLA MANUFACTURING CO.
114 Liberty Street, New York 6, N. Y.

DURABLA®

Representatives: E. J. Mitchell Co., Houston, Tulsa, Baton Rouge, Midland; The Ram Co., Monterey Park (L.A.), Calif.

DM-39

For more data on advertised products, use cards, last page.



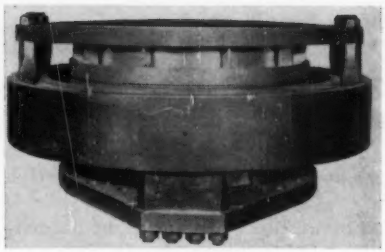
near each end to assure free thermal expansion. Four legs that fold up against the end plates during shipment, bolt upright to hold the heater in sloping position about 6 inches above the tank bottom, thus assuring complete submersion under all normal operating conditions. The Griscom-Russell Co.

Circle E5 green card, last page

Expansion Joint Solves Complex Piping Problems

Gimbal type expansion joints which absorb angular rotation in all planes offer a simple and economical solution to the problem created by complex piping and equipment expansion.

Each gimbal expansion joint is controlled by a structural system consisting of two sets of hinges, oriented at 90 degrees apart, coupled to a common gimbal ring. This structure restricts the expansion joint to angular



rotation in any plane, absorbs pressure thrust and limits torsional loading on the bellows. It may be designed to carry piping weight, wind loads and other dead weights thus eliminating guides, supports, anchors and restraints which might otherwise be required.

Gimbal expansion joints are most frequently applied in sets of two, so that the expansion joint system can absorb lateral deflection in any plane. Since the amount of lateral deflection which can be absorbed by the system is directly proportional to the distance between the two expansion joints, a great deal of design flexibility is available. Where piping configuration and applied movements warrant, a hinged expansion joint may be added to the system to permit absorption of lateral movements perpendicular to the circular orbit of the gimbal system. Zallea Brothers.

Circle E6 green card, last page

Catalog Covers Complete Stainless Steel Valve Line

A 132-page illustrated catalog covering the company's complete line of stainless steel valves and accessories includes ball, gate, globe, check, angle, "Y", sampling, tank, and needle valves.

Valves are shown in a wide range of types, sizes, end connections, and temperature and pressure ratings. The catalog covers design features, special operating mechanisms, materials of construction, principal dimensions, and cross-section drawings. Cooper Alloy Corp.

Circle E7 green card, last page

Pneumatic Receiver Built To Completely New Design

A new line of 4-inch chart metagraphic pneumatic receivers has been built to a completely new design. These instruments, designated as the Series 670, are best described as being user-oriented. Many new features, both standard and optional, combine

FLINT STEEL

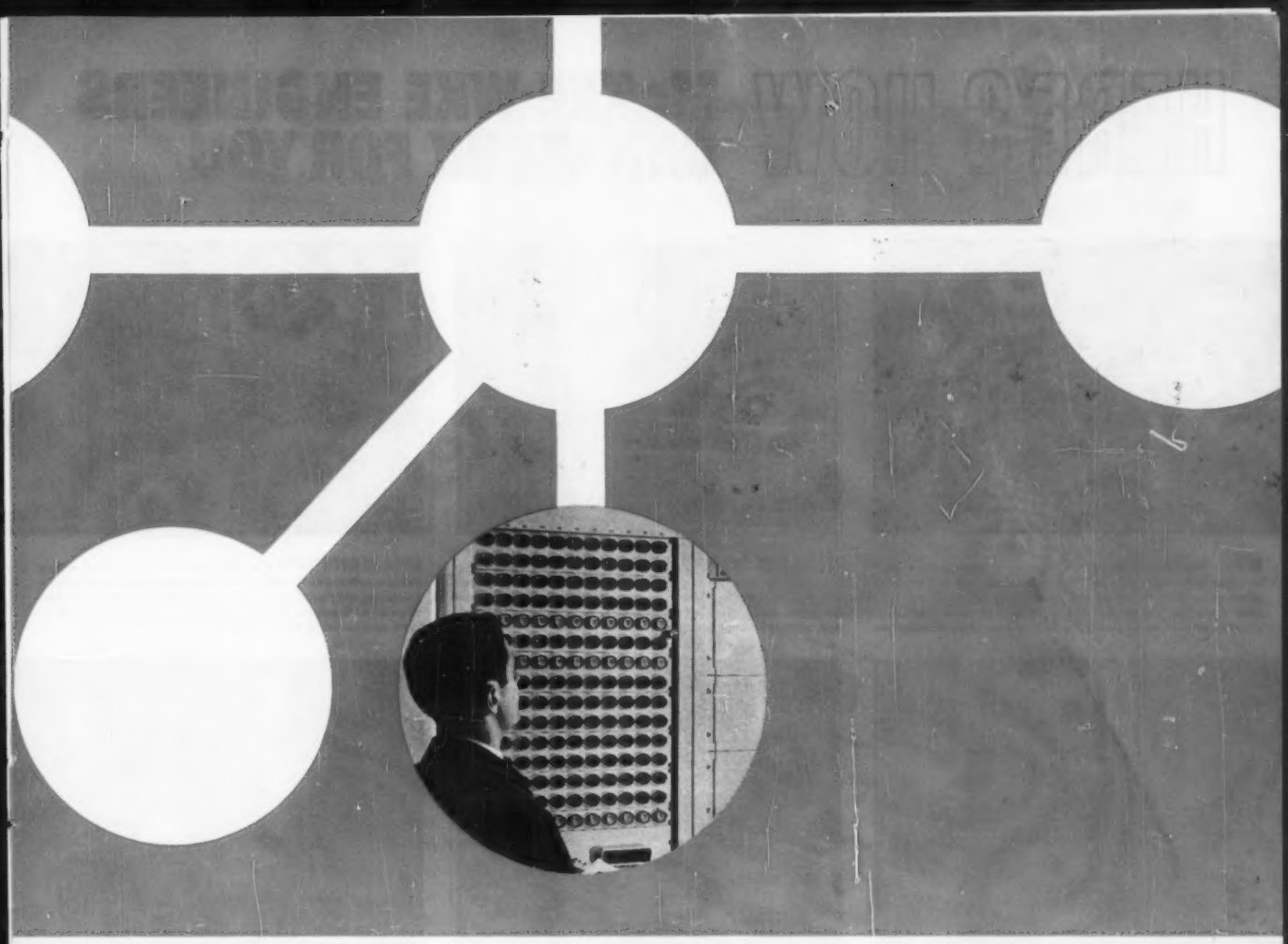
Steelmanship☆ ®

Deisobutanizer tower 9′ dia. x 166′ length, and eight other process vessels totaling 435 tons of plate.
FABRICATOR: FLINT STEEL CORPORATION
TULSA, OKLAHOMA

☆Superior craftsmanship in fabricating the right steel for the job, to the rigid specifications set by the customer.

STEEL PLATE FABRICATORS ASSOCIATION

FLINT STEEL CORPORATION
TULSA . . . TWX, TU-1914 . . . MEMPHIS



PROCESS PROTECTOR

Hagan AIM—centralized monitoring of all important variables

Temperatures, pressures, flows, levels, closures, in fact any input that can be represented by DC voltages as low as 10 millivolts full scale can be monitored by the Hagan AIM (Alarm Indicating Monitor) with an accuracy of plus or minus 0.1% full scale.

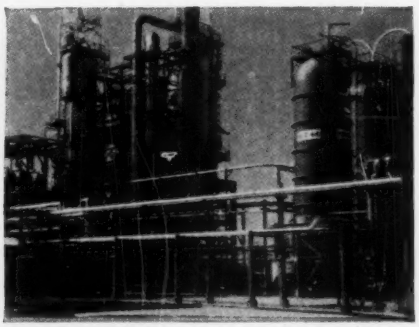
Fast and reliable, the Hagan AIM is compact—for example, the readout and alarm panel for 200 alarm points will fit into a 19″ x 47¼″ panel area. Combining all alarm functions in one instrument, AIM can be set for high or low alarm points, or both. Seconds after a monitored variable goes out of bounds, AIM energizes the alarm light and sounds a warning horn. The horn can be shut off, but the light stays lit until the condition is corrected. AIM safeguards both equipment and process from the shattering damage that a single runaway variable can produce. Now *one* man can watchdog a complete process line, taking corrective action before damage is done.

AIM is one component of the complete Hagan line of process controls, which include primary elements, transducers, controllers, recorders and final control elements. Designed for use with existing installations or for complete new systems, the Hagan line can save you money in terms of more accurate control with minimum adjustment and maintenance. For information, write or phone HAGAN CHEMICALS AND CONTROLS, INC., Hagan Center, Pittsburgh 30, Pa.

HAGAN

HERE'S HOW McKEE-WKE ENGINEERS CAN WORK FOR YOU

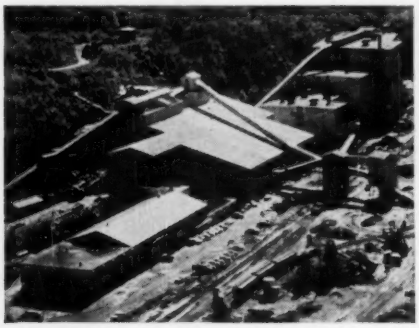
BLAST FURNACES Sound planning and experienced construction know-how put these three furnaces and the sintering plant at an Eastern Pennsylvania plant in production on scheduled dates. McKee engineering services help make your new-plant investment start earning profits at the earliest possible date.



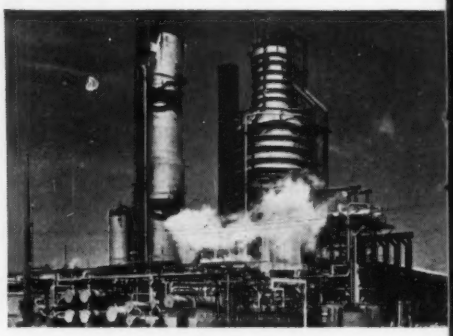
PETROLEUM PROCESSING This new fluid catalytic cracker is a typical result of McKee services at work. A single turn-key contract converted a bare construction site into a producing plant that is delivering specified performance. Knowledge, experience and ability, instantly available, did the job.

OPEN-HEARTH SHOP One of a wide variety of plants McKee designs and builds for the steel industry, this open-hearth shop is producing efficiently in the Chicago District. Our intimate knowledge of steel making, from mine to finished steel, makes McKee-WKE services work more effectively for you.

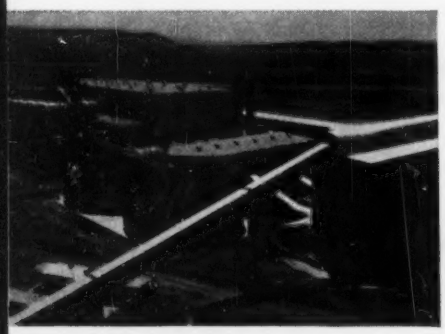
COPPER SMELTING In non-ferrous metals your first call for engineering and construction should be for McKee-WKE services. This large, fully integrated plant shows you why. Newest copper smelter in America, it was designed, and completed ahead of schedule by WKE. Here again, you can reach into a pool of engineering talent devoted to a specialized field.



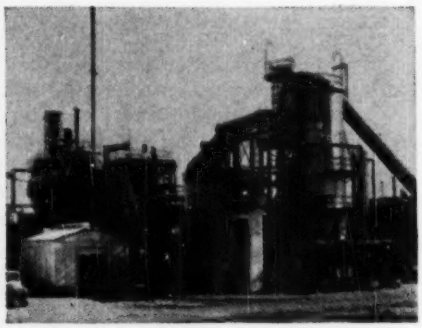
ORE BENEFICIATION WKE leadership in ore beneficiation is combined with McKee leadership in pelletizing. This 650,000-ton pelletizing plant, designed and built by McKee, is fed by an iron ore concentrator designed and built by WKE. The specialized fund of McKee-WKE knowledge that produced them can give you superior results, too.



CRUDE OIL DISTILLATION High capacity and almost automatic operation make this combination atmospheric and vacuum unit an outstanding example of McKee design and construction. Capable of processing upward of 150,000 barrels per stream day, it is, so far as we know, the world's largest crude unit — proof that the industry entrusts the big ones to McKee.



URANIUM ORE CONCENTRATION Here is another project which illustrates the broad scope of our services. WKE engineers have served this industry since its commercial birth with complete design and construction of 10 of the 25 U.S. uranium ore concentration plants, and participation on many of the other fifteen. WKE's thorough knowledge of ores and minerals, intelligently applied, can save you time and money.



CHEMICAL PROCESSING This modern sulfuric acid plant joins the ranks of McKee-WKE plants designed to produce sulfuric acid, nitric acid, hydrazine, urea, polyvinyl chloride, chemicals from coal and similar products. Our broad, diversified knowledge in petroleum, petrochemicals, metals and minerals helps McKee and Western Knapp engineers build more efficient, more economical chemical plants for your company.

AGGREGATE PROCESSING This $5,000,000 aggregate processing plant shows how experience gained in one area of industry is used to advantage in another. The new plant employs certain methods originally developed by Western Knapp engineers for the mining and minerals producing industries. The ability to apply wide knowledge from many fields is another reason McKee-WKE services should be working for you.

THE FULL STORY OF HOW McKEE AND WKE CAN WORK FOR YOU ON YOUR SPECIFIC PROJECT IS YOURS FOR THE ASKING. A CALL TO OUR NEAREST OFFICE WILL BRING YOU A PROMPT RESPONSE

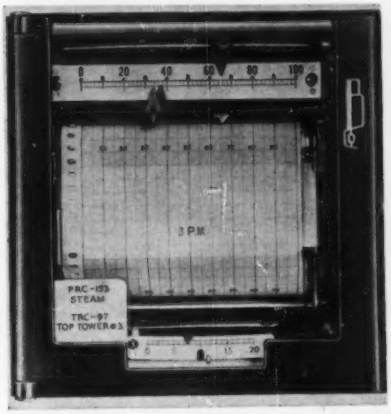
THE McKEE ORGANIZATION

ARTHUR G. McKEE & COMPANY, 2300 Chester Ave., Cleveland 1, Ohio. *Offices:* New York; Union, N. J.; Washington, D. C.; Houston, Texas. *Subsidiaries:* Toronto and Montreal, Canada; Mexico City, Mexico; Sao Paulo, Brazil; Buenos Aires, Argentina; McKee Head Wrightson, London.

WESTERN KNAPP ENGINEERING CO. 650 Fifth St., San Francisco 7, Calif. *Offices:* New York; Chicago; Hibbing, Minn.

INTERNATIONAL ENGINEERING AND CONSTRUCTION SERVICES

New Equipment . . .



to make the receivers easy to install, use and maintain. Nine models are presently available to meet any control requirement.

The 4-inch-calibrated width chart has rectilinear coordinates for easy reading and interpretation. The chart is mounted on a chart-drive that is removable from the instrument chassis, facilitating fast, easy chart changing, and allowing access to the front end of the chassis while it is still in the case. Capillary inking systems, (up to three records) provide trouble-free recording, and are refillable from the front of the case.

All pointers on the instrument are brightly colored and distinctively shaped. This allows the operator to determine at a glance, even from across the room, whether the system is functioning properly. The Bristol Company.

Circle E8 green card, last page

Safety Relief Valves Eliminate Dual System

The new 8500 series safety relief valve manifolds are available with two, three or four safety relief valves in threaded mounts. These manifolds are designed for continuous, uninterrupted service on pressurized storage tanks containing LPG, butadiene and other selected hydrocarbons.

Designed for direct connection to a flanged tank opening, Reg0 manifolds require no inlet piping or shut-off valves. Because of a unique hand-wheel operation, the necessity for dual relief valve systems is eliminated.

Even while the storage container is under pressure, any one of the safety relief valves may be removed for servicing without hazardous or wasteful

STRONG is the word for Centrifugally Cast Pipe

. . . and the alloying is selected so that you will get high resistance to corrosion or high resistance to extreme heat or high resistance to both, as you require.

Centrifugally Cast Pipe has been a major DURALOY item since 1933 when we pioneered such high alloy castings in this country. Standard pipe production is in the following classification:

Outside Diameter	Minimum Wall	Length
2½" to 3"	1/4"	88" maximum
3" to 6" Inclusive	5/16"	110" maximum
Over 6" to 12" Inclusive	3/8"	168" maximum, 24" minimum
Over 12" to 14" Inclusive	7/16"	168" maximum, 24" minimum
Over 14" to 20" Inclusive	1/2"	180" maximum, 48" minimum
Over 20" to 24" Inclusive	1/2"	88" maximum
Over 24" to 32" Inclusive	5/8"	80" maximum

ALLOY CASTING INSTITUTE ACI MEMBER

RESISTANT is the word for Chrome-Nickel Alloying

The strength of Centrifugally Cast Pipe comes largely from the exceptionally uniform dense grain structure.

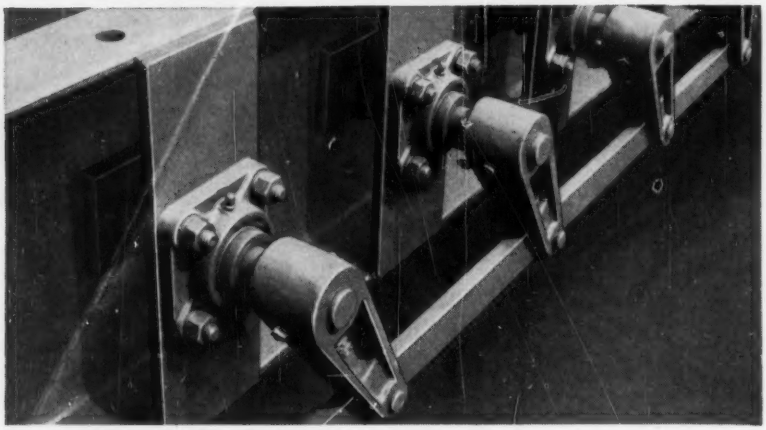
If you require a gas or liquid pipe line or a process tube requirement calling for high strength plus high resistance to corrosion and/or temperatures in the piping, DURALOY Centrifugally Cast Pipe will meet your specifications with complete satisfaction. This is the record of our castings in industry for many, many years.

The DURALOY Company
OFFICE AND PLANT: Scottdale, Pa.
EASTERN OFFICE: 12 East 41st Street, New York 17, N. Y.
CHICAGO OFFICE: 332 South Michigan Avenue
DETROIT OFFICE: 23908 Woodward Avenue, Pleasant Ridge, Mich.

For more data on advertised products, use cards, last page.

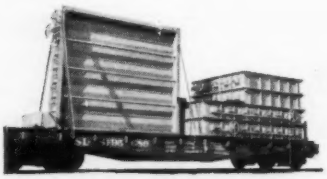
CUSTOM-DESIGNED DAMPERS

FOR POSITIVE DRAFT CONTROL



Whirlex multi-louvered dampers give positive control of your draft problems. Whatever your requirements, Whirlex dampers are custom-engineered, in both louvered and opposed-blade designs, for all types and sizes of applications. And, whether in difficult conditions requiring gas-tight seals and closure strips, or linkages for operating with combustion control equipment, or dust-seal equipped bearings for pressure systems, Whirlex offers equipment *custom designed* to meet your needs.

Whirlex all-welded dampers are completely integrated and shop-assembled. They assure you of quality controlled, high-efficiency equipment with a consistently low operating and maintenance cost.

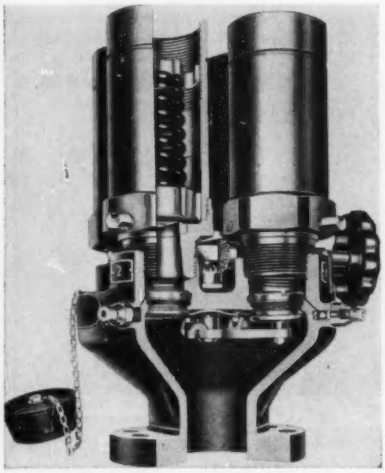


Remember, when Whirlex multi-louvered dampers work for you, you get the *best* draft control for the *least* cost. Ask for bulletin #DA-16

THE FLY ASH ARRESTOR CORP
205 North 1st Street / Birmingham, Alabama
420 Lexington Avenue
New York 17, N.Y.

Mechanical Collectors — Wet Collectors
Induced Draft Fans — Forced Draft Fans — Exhaust Fans
Self Supporting Stacks — Duct Work

New Equipment . . .



discharge of product because a handwheel selectively closes off the entrance port to the particular safety relief valve being removed. Direct labor involved in the removal and replacement of this relief valve does not normally exceed 30 to 40 minutes. All manifolds are sized to permit this removal and still retain full discharge capacity for the particular storage container.

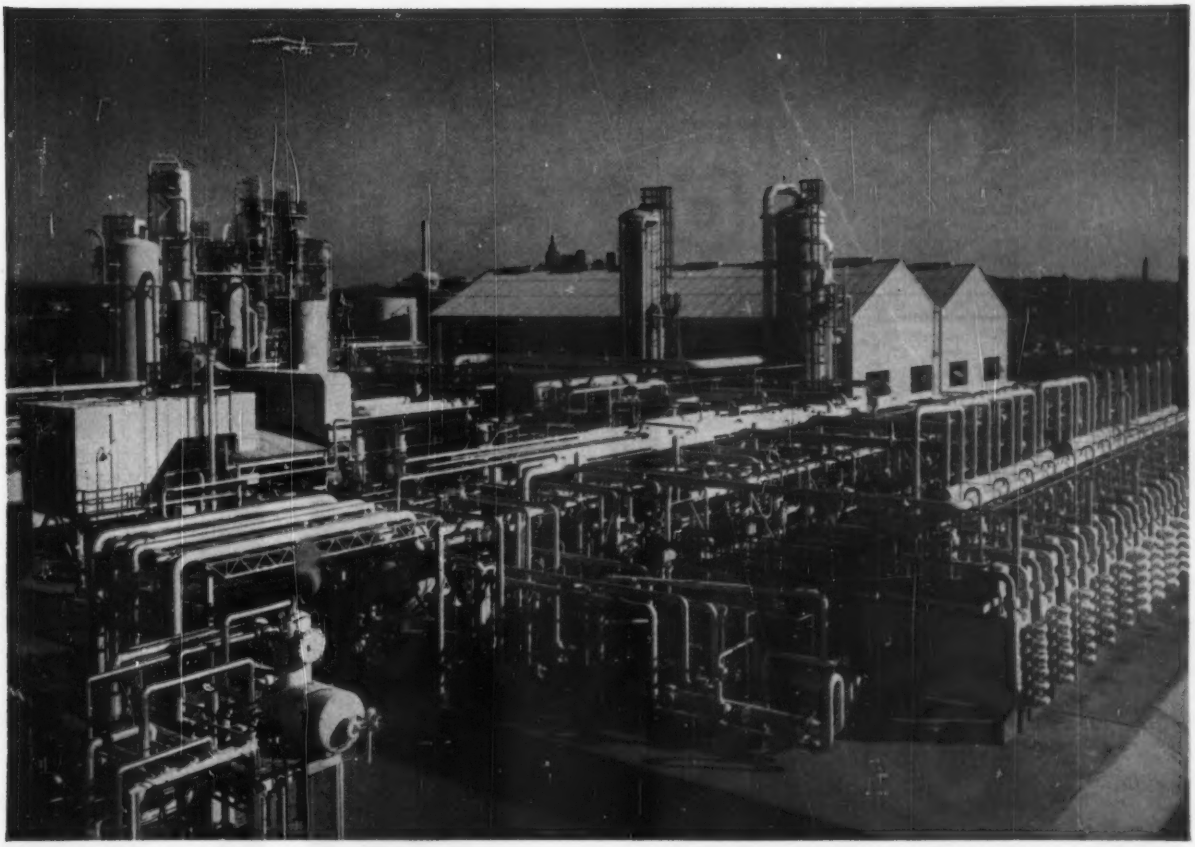
Maximum protection without waste is assured by the "pop-action" design of the safety relief valves. Resilient seat discs assure a "bubble-tight" seal. These valves open only slightly to relieve moderately excessive pressures (keeping waste to a minimum) but "pop" open to full-discharge capacity when tank pressure increases beyond 120 percent of the set pressure. After discharging, the valves automatically reseat firmly. The Bastian-Blessing Co.

Circle E9 green card, last page

Curves Size Valves in Flashing Fluid Service

The sizing of valves for saturated (flashing) fluids is a highly complex problem. Many different approaches have been taken, few with considerable success. The one based on the downstream density of the liquid-vapor mixture has proven to be the most accurate. Now curves have been developed for some of the most commonly used fluids that permit the instrument engineer using this approach to accurately size a valve for flashing fluid conditions with only a few simple calculations.

This is the so-called, lower-density



New "Black Art" plant for DX Sunray

This ultra-modern, high efficiency, dewaxing and wax fractionation unit was designed and constructed by Foster Wheeler at DX Sunray Oil Company's Tulsa, Oklahoma, refinery. It produces approximately 5800 bbl/day of lubricating oils and 137 tons/day of paraffin and microcrystalline waxes with an oil content of less than 0.2%. Ten different feeds are processed by blocked operation, ranging from 65 vis/100 F spindle distillate to Bright Stock and petrolatum.

The new unit's compactness, accessibility, versatility, and its instrumentation and control show direct application of Foster Wheeler's long engineering and process experience with the so-called "black art" of dewaxing and wax fractionation. The entire installation is tightly planned into a 230 ft by 308 ft area. Wax and oil are separated by selective solvency, using a blend of methyl-ethyl-ketone and toluol as the solvent. The solvent is also used in wax fractionation. Automatic flow controllers regulate solvent-to-feed ratios and other critical volumes.

The installation's gas turbine is the first used as a prime mover in the dewaxing process. An FW waste heat boiler utilizes turbine exhaust gases to produce all process steam. The propane and flue gas compressors operate on a single turbine shaft without gear reduction.

This plant is another example of Foster Wheeler's ability to serve you . . . to build your plant . . . any process . . . any size . . . anywhere. Foster Wheeler Corporation, 666 Fifth Avenue, New York 19, New York.

Heat Engineered products, plants and processes . . . for the world's industrial progress.

FOSTER FW WHEELER

NEW YORK TORONTO LONDON PARIS MILAN TOKYO

For more data on advertised products, use cards, last page.

Durable paints that keep uniform color

That's what you get when you specify paints made with M50® Basic Lead Silico Chromate pigment for your gas stations and tank trucks.

Keeping stations looking bright and inviting to customers can be a real problem. You can minimize this problem by specifying paints made with *M50*® Basic Lead Silico Chromate pigment—the pigment that puts anti-corrosion protection in every coat . . . plus weather resistance against fading and chalking.

M50 pigment provides "Defense-in-Depth"—keeps paint *uniformly* bright and attractive longer.

In addition to superior corrosion protection, *M50* pigment permits an *unusually wide range of color selection.* Paints made with *M50* pigment can be compounded in bright hues, soft pastels and other color variations to spruce up your gas station signs, pumps and tank trucks... make them attractive outdoor advertisements for your company.

Next time you buy paint for decorative metal protection, specify paints made with *M50* Basic Lead Silico Chromate – the pigment that puts anti-corrosion protection in every coat *and* provides durability, uniform resistance to weathering and wide color range.

M50 an **oncor**® *Pigment... A Development of* **National Lead Company**

General Offices: 111 Broadway, New York 6, N.Y.

For more data on advertised products, use cards, last page.

technique, getting its name from the fact that the value sizing correction is based on the lower density of the vapor-liquid mixture that exists after flashing occurs.

Curves have been developed for saturated water, ammonia, chlorine, sulfur dioxide, dowtherm "A", freon 22, isobutane, methane, ethylene, propane, propylene, normal butane and methylene chloride, all in saturated condition.

All of the curves plus formulas for their use are available on request. Conoflow Corp.

Circle E10 green card, last page

Spark Plug Finds Oil-Water Interface During Process

The necessity for separating gas, oil and water in an oil cracking process at the Sunbury Research Center, British Petroleum Co., Ltd., set its own particular problem when it became necessary to detect the interface between oil and water. Due to the tarry nature of the oil, any sight glass became quickly fouled. Conductivity measurement was tried but proved unsuitable since the tarry oil coated the probe and interfered with the detection.

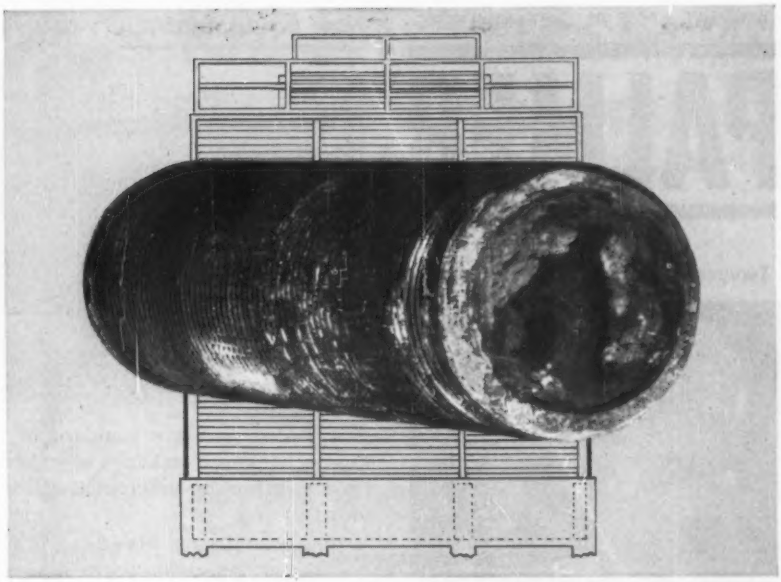
A sparking plug was modified for use as a probe in conjunction with the "Proximitor" unit. As the aqueous layer reaches the probe a relay operates, due to differences between the dielectric constants of the aqueous and oil phases, actuating a magnetic valve which controls the water off-take. The aqueous phase often contains small amounts of emulsified oil, but the presence of this has not affected detection of the interface.

Complete details are available. Electronic Machine Co., Ltd.

Circle E11 green card, last page

Liquid Process Streams Controlled by Refraction

Control of liquid process streams based on very small changes in index of refraction of the stream compared



COOLING WATER CORROSION MUST BE STOPPED!

Unchecked scale deposit and corrosion in your air conditioning system can cut its life by years . . . increase maintenance and replacement problems several-fold.

Bird-Archer Series 5900 chromate formulations stop severe scaling and corrosion easily, effectively and economically, adjust pH to safe, neutral ranges. In small systems, treatments are added to the circulating water directly from the shipping container through a specially designed Micro-Feeder, eliminating the necessity for manual, daily chemical feeding. For larger units special chemical feed equipment is available.

Write for Bulletin 117 and the name of the Bird-Archer Service Engineer nearest you.

BA-100

BIRD-ARCHER

WATER TREATING CONSULTANTS

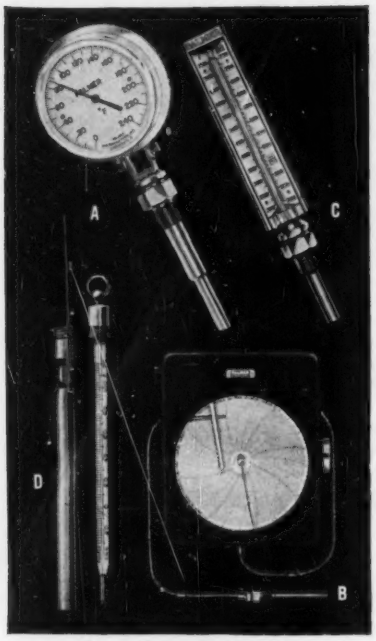
The BIRD-ARCHER Company, 4337 N. American St., Phila. 40, Pa. / New York • Chicago

The BIRD-ARCHER CO. of California, 415 Brannan St., San Francisco • Offices in Canada and Mexico

A GREAT NAME IN THERMOMETERS

PALMER

Mercury Actuated
Temperature Indicating Instruments



A—4½" DIAL THERMOMETERS: Made in 3 types to suit any requirements. Rigid stem, wall or flush mounted, 11 inches of scale reading. Interchangeable with standard industrial separable sockets. Stem can be placed at any angle and case can be rotated to any readable position.

B—RECORDING THERMOMETERS: Twelve inch die-cast aluminum case with black finish. Single or multiple pen construction. Electric or spring wound clock, 24 hour or 7 Day Revolution. Flexible Armor and bulb of stainless steel. Ranges: —40 +950° F or Equivalent in °C.

C—INDUSTRIAL THERMOMETERS: Red-Reading Mercury—Extruded brass case—chrome finish. Ranges: —40 +950° or Equivalent in °C.

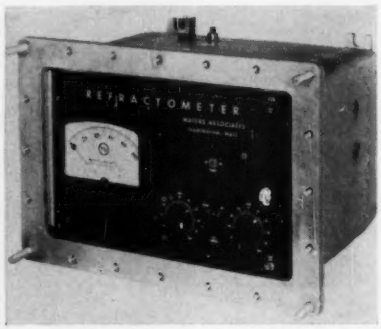
D—RED-READING MERCURY LABORATORY THERMOMETERS: Thoroughly annealed for permanent accuracy. Complete line A.S.T.M. and fractional division types.

FOR COMPLETE INFORMATION WRITE FOR CATALOG

PALMER

PALMER THERMOMETERS, INC.
Cincinnati 12, Ohio • MElrose 1 1500

New Equipment . . .



to a sealed reference standard or a flowing reference standard is possible by a new process differential refractometer.

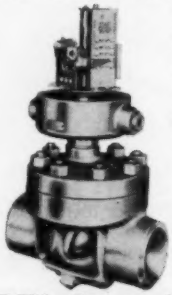
Where accurate blending is required and one stream varies in composition, the flowing reference refractometer provides a simple accurate analysis.

The instrument can be used to control a fractionating column by sealing an optimum sample in the cell and controlling operation to maintain the column at this optimum condition. Waters Associates.

Circle E12 green card, last page

Swing Check Plus Flow Control All in One Valve

A full-flow, swing-check valve has been designed that offers all the advantages of a check valve plus all the advantages of a flow control. For practically any liquid at any pressure or temperature, the valve makes one compact package.



The new Model FCV offers a valve disc magnetically coupled to the Magnetrol switch mechanism, which features mercury-to-mercury switch contacts.

The unit is designed to remotely signal flow or no-flow through the valve, and/or provide an interlock safety control in start-up or shutdown, flow or no-flow. It can also reliably indicate the position of the valve disc at any point from full closed to full open.

The unit is fully field adjustable. Its indexed and adjustable-electric switching element provides signal at

INSTRUMENT
DAVIS
DIVISION

GAS ANALYSIS INSTRUMENTS

Continuous and Portable units

✓ PARAMAGNETIC OXYGEN MEASUREMENT

Detects oxygen content of gases. Simple non-electronic circuit. Fast response—95% reading in 15 seconds. Ranges from 0-5% O_2 to 0-100% O_2. EXPLOSIONPROOF CONSTRUCTION AVAILABLE.

✓ PARTS-PER-MILLION GAS DETECTION

Measurement of P.P.M. gas concentration. Used in air pollution studies, contaminant control, detection of toxic gases and vapors. Compact units for field surveys as well as universal mounting cabinets and self-standing cubicles.

✓ COMBUSTIBLE GAS ANALYZERS

Complete diversified line of systems for detection of combustible gases and vapors in work areas; litho and coating oven atmosphere control; etc. Control of combustibles in inert gas streams.

✓ THERMAL CONDUCTIVITY ANALYZERS

Measurement of concentration to one gas component in a mixture of gases, utilizing sensitive filaments as the detector. Applicable for determination of: H_2 in O_2. N_2 mixtures; Argon in air; hydrogen purity; CO_2 in flue gas, etc.

Write for Descriptive Literature

DAVIS INSTRUMENTS
A Division of Davis Emergency Equipment Co., Inc.
80A Halleck St., Newark 4, N. J.

reliable liquid level or flow control

A **sleeve**, raised and lowered within a nonmagnetic tube by any suitable sensing means, as liquid level or flow rates change, attracts or releases a permanent magnet attached to a **mercury switch** outside the tube. That's all there is to it!

at practically any temperature or pressure

MAGNETROL

The positive pull of a permanent magnet replaces all bellows, packing glands, diaphragms and electrodes — eliminates all wearing parts.

Magnetrols operate indefinitely to control the level or flow of virtually *any* liquid — at practically *any* temperature or pressure. They are so simple that only a simple change in component material is normally needed to adapt standard units to even the most unusual operating requirements. Of course, "special" Magnetrols can be developed to meet any specific plant need.

Magnetrols are available for controlling *liquid level* changes from ¼" to as much as 150' and more — with single or multi-stage switching; *flow switches* to signal start, stop or insufficient flow within fractions of gpm rates.

Fill in coupon and attach to your letterhead for full information.

18

MAGNETROL, Inc. 5312 Belmont Road, Downers Grove, Ill.
Please send me catalog data and full information on Magnetrol
☐ Liquid Level Controls ☐ Flow Controls

Name_____

New RIDGID No. 141 Geared Threader

For 2½", 3", 3½", 4" Pipe and Conduit

Save Time...Cut Costs on all large threading jobs!

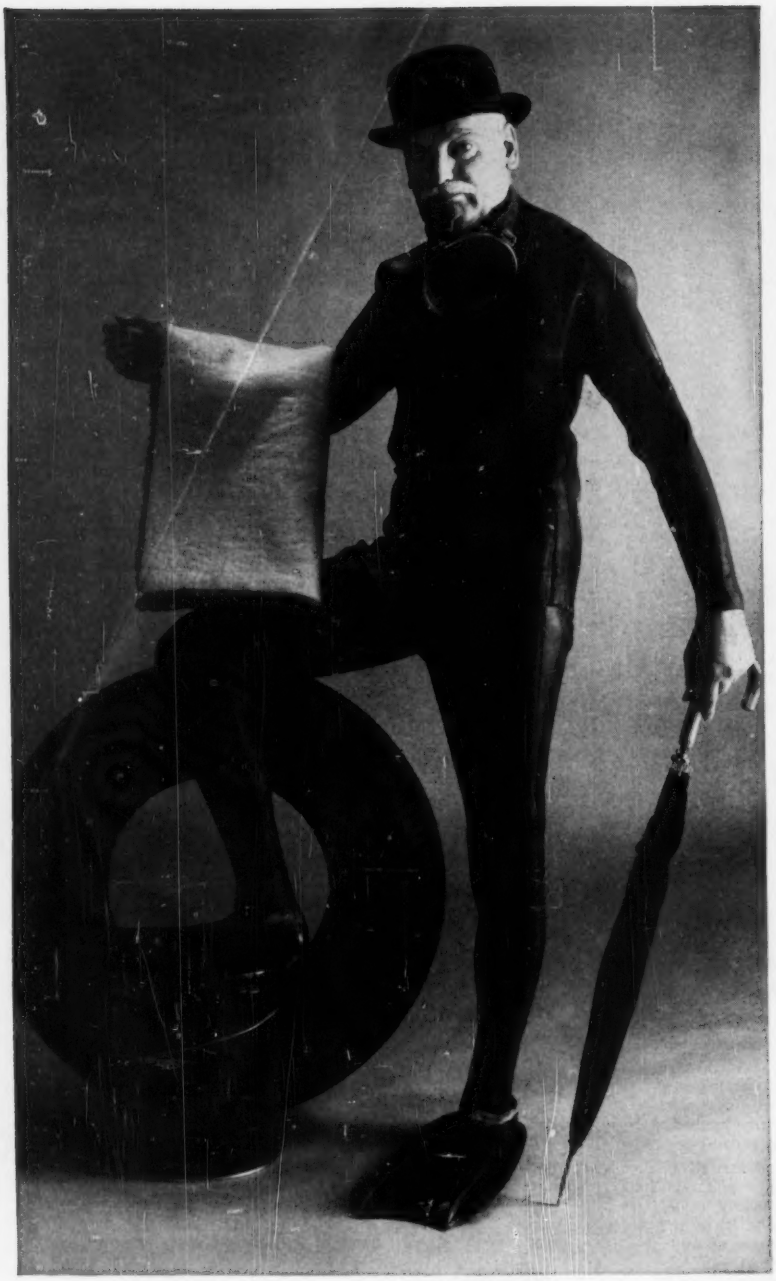
1. Only 1 Set of High Speed Dies threads 2½", 3", 3½" and 4" pipe and conduit. No extra die sets to change or lose! Die size selector plate sets quickly and locks at desired size. Easy adjustment for tapered, straight, over or under size threads.

2. Jam-Proof for safe threading by power or hand. Drive pinion kicks out automatically. Die head *Can't Jam* . . . avoids costly repairs and delay.

3. New Fast-Action, Cam-Type Workholder sets to size by quick turn of collar. Set screw holds work centered for perfect threads every time . . . adjustable for drip threads.

Your Supply House has them!
Order your new RIDGID No. 141 Threader today!

RIDGID
The Ridge Tool Company • Elyria, Ohio, U.S.A.



BIG IN THE RUBBER PICTURE

The simple one-step HOUDRY DEHYDROGENATION PROCESS produces butadiene for synthetic rubber throughout the world. In addition, it can produce butene. Other mon- and diolefins may also be produced from the corresponding saturated hydrocarbons.

Capacity placed on stream in the U.S. since World War II is capable of producing very close to 50 per cent of the butadiene required by the domestic synthetic rubber industry. The HOUDRY DEHYDROGENATION PROCESS is also on stream in plants in Italy, West Germany, and Japan. Write for a full description.

***HOUDRY**
PROCESS CORPORATION
1528 Walnut Street, Philadelphia 2, Pa.
*Houdry means Progress...through Catalysis

SADI

VALVE OPERATORS
Adaptable to NEW and EXISTING VALVES

THOUSANDS of operators in service throughout the world, typical examples of SADI power transmission equipment quality

SADI

HAULAGE CAPSTANS
TRANSPORTABLE ECONOMICAL DEPENDABLE

SADI SPRL
4, RUE CARBURANTS
BRUSSELS 19 — BELGIUM

any pre-set position of the valve disc. From 10 to 50 degrees external adjustment is provided and there is no need to isolate the valve from the line when making field adjustments. Magnetrol, Inc.

Circle E13 green card, last page

Weld Couplet Is Designed To Assure Correct Alignment

Weld couplets with a special "weld ring" adapt to any pipe or vessel curvature by simply adjusting the height position of the couplet in the opening when welding. This characteristic assures correct positioning and alignment, a stronger weld without distortion, and no inside "icicles" of welding material.

Couplets are available in threaded or socket weld types, in sizes from ¼ through 2 inches, in carbon steel conforming to ASTM specifications. Other materials can be supplied. Henry Vogt Machine Co.

Circle E14 green card, last page

Castable Refractory Book Gives Furnace Application

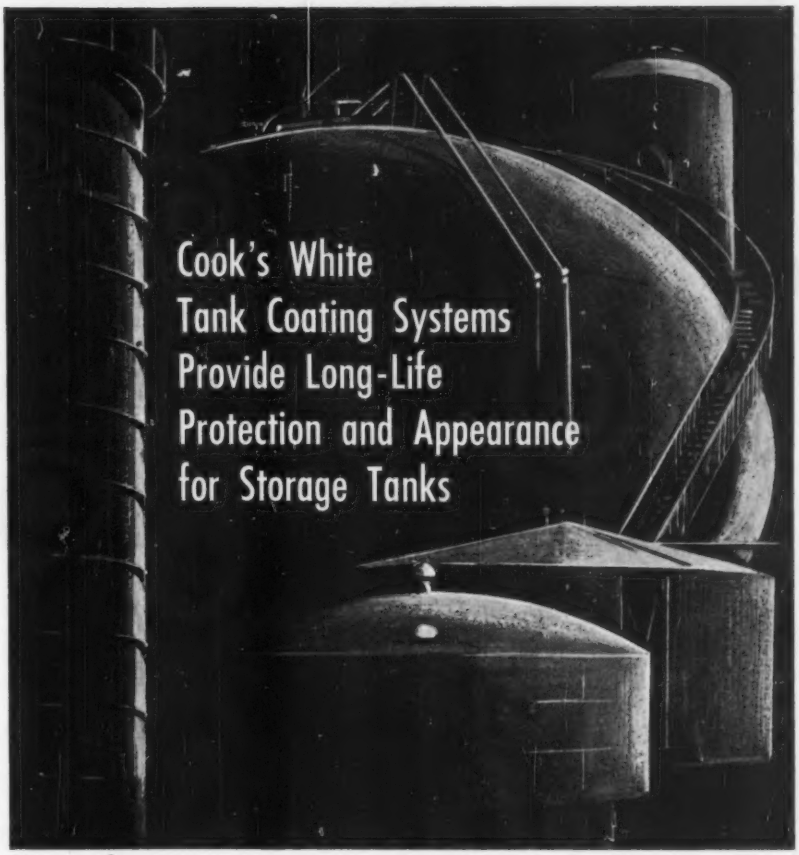
A newly revised, 24-page booklet describes the physical characteristics of a variety of castable refractories and their application. The booklet tells about a full range of products for use in furnaces ranging in temperature from 700° to 3,5000° F and with characteristics designed to meet the special conditions imposed on refractories by the demands of furnace operation, atmospheres, fuels and service conditions. Kaiser Refractories & Chem. Div.

Circle E15 green card, last page

Butyl-Insulated Electrical Cable Is Ozone Resistant

Latest information on cables insulated with Okonex butyl-base, high-voltage insulation is included in a new 48-page reference manual.

This service-proved, butyl-base rubber insulation designed for multi-purpose service up to 90° C, is extremely resistant to ozone, heat and

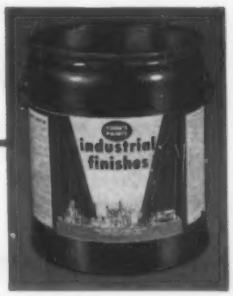


Here's how: Both Cook's Tank White, and Cook's Tankshield One-Coat White are specially formulated to be gas proof and mildew resistant . . . to provide tough, long-lasting protection against corrosion. And highly reflective Cook's whites repel hot sunrays, keeping evaporation losses within the tank to a minimum. Cook systems are also self-cleansing . . . retain their excellent appearance. For long-term dividends, invest now in Cook's exterior tank coating systems.

Cook's Tank Paint White is a long-oil alkyd resin base finish with years of proven durability. Ideal for both new and old tank installation . . . it provides good build and a tough film right from the start.

Cook's Tankshield-A One Coat White is a long-oil alkyd resin base finish, and Cook's Tankshield-S One-Coat White is a long-oil epoxy ester base finish with extra resistance to mild chemical and coastal corrosive atmospheres. Both save you important money on application costs. Under normal outdoor spraying conditions, 3 mils wet film thickness may be applied with one pass of the spray gun—and three such passes may be made without danger of sagging. Result: a dry film thickness of 5 to 6 mils with only one coat.

Investigate Cook's white tank coating systems now. And note this—in addition to whites, Cook's can supply grays, aluminums, pastels or any other desired tank color. **For tanks, Cook's has it!**



COOK'S PAINTS

COOK PAINT AND VARNISH COMPANY

KANSAS CITY	DETROIT	HOUSTON
P. O. Box 389	P. O. Box 5507	P. O. Box 3089
GRand 1-4800	UNiversity 1-1000	CApitol 8-2391
Teletype KC584	Teletype DE293	Teletype HO29

For more data on advertised products, use cards, last page.

REPORT TO REFINERS:

HOW MUCH CAN CHEMICAL ADDITIVES DO FOR REFINED PRODUCTS?

ARMOUR IDEA CHEMICALS

an informative look at the use of Armour Idea Chemicals in gasoline, fuel oil, lubricants, asphalts... plus a glimpse at the research that is helping to solve today's problems and investigating tomorrow's needs

GASOLINE ADDITIVES

More and more petroleum refiners are becoming aware of the abilities of Armour Duomeen® and Armeen® compounds as gasoline additives.

Duomeens O and C adsorb onto the metal surfaces of carburetors, forming monomolecular films which function as effective anti-icers. As a result, moisture—which causes engines to stall at temperatures around 36° F.—does not adhere to the surface. Even though ice particles may form under extreme conditions, they will not collect on the carburetor surface to block the flow of the air-gas mixture.

Recent investigations have revealed another important ability of Armeens and Duomeens: they help maintain engine cleanliness when used in summer gasolines.

Armour researchers are continually investigating the other Idea Chemicals for use as gasoline additives. Recent tests demonstrate that a new class of polyfunctional amines offer outstanding performance as corrosion inhibitors, de-icers and detergents.

FUEL OIL ADDITIVES

To supply bright, sludge-free fuel oil is the ultimate aim of every refiner. Many factors have made this a difficult goal to reach: stocks, fuel blends, transportation difficulties, processing. These conditions often result in fuel oil instability, which is further aggravated by the long storage periods necessary between peak seasonal demands.

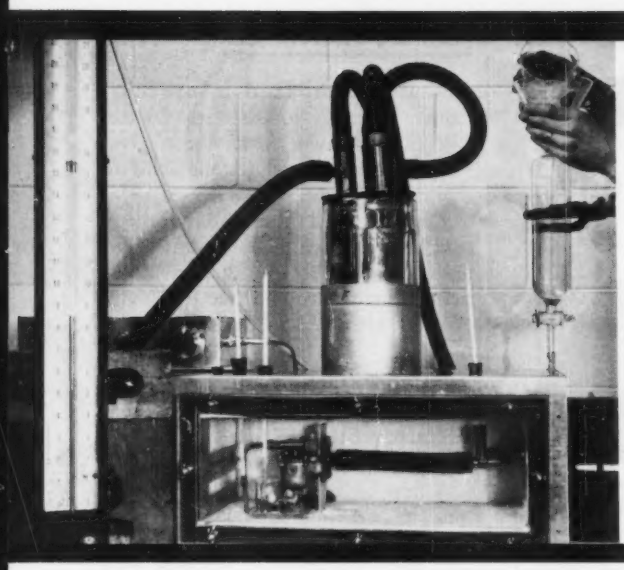
Two Armour chemicals relieve the problem. Armour Armolad® compounds help inhibit sludge formation; Armour Arquad® additives disperse it when it is already present.

The Armolads disrupt the normal chain reaction of oxidation and polymerization—thus minimize gum formation. In addition to stabilizing the oil in this manner, they also maintain color and filterability.

Armour Arquads 2C and 2S provide the ounce of prevention that's worth a pound of cure. These cationic surface active agents peptize the sludge while it is in the tank; the sludge thus passes through the burner system without plugging filters and nozzles. Arquads also act as detergents. Sludge already deposited on the screen can be resuspended and dispersed as described above. Another common source of possible contamination—mixing of fuels by the consumer -can be remedied also by the presence of a good dispersant additive.

LUBRICANT ADDITIVES

With advances in technology, lube oil requirements have become increasingly demanding. A progressive research program has been established at Armour to improve lubricant performance characteristics, such as wettability and lubricity.



ARMOUR RESEARCHERS AT WORK

TESTING CARBURETOR DE-ICING... At left is a test determining the ability of Armour additives to prevent carburetor icing. The carburetor is enclosed and air and humidity are uniformly maintained. A vacuum pump operates the carburetor, and icing is determined by the increase in vacuum. Armour chemicals are then tested for speed and efficiency of de-icing.

TESTING OIL STABILITY... Here, at right, an Armour technician measures the oxidation stability of turbine and hydraulic oils. The oils are placed in a controlled-temperature bath. Oxygen is bubbled through at a determined rate and the solution is then tested for acid and gum formation, viscosity stability, and corrosion.

Careful scrutiny is being given to the area of synthetic lubricants. Recent tests reveal the efficiency of tertiary amine chemicals in stabilizing synthetic diester lubricants. One of these tertiaries, Armeen M2HT, reduces the acid attack on bearings at concentrations as low as 0.1%.

ASPHALT ADDITIVES

In recent years greater use is being made of asphalt emulsions because they are less expensive and less hazardous than asphalt cements. Also, they can be stored and applied at much lower temperatures.

Armour cationic chemicals serve as efficient emulsifiers for new cationic asphalt emulsions. Duomeen T, because of its superior adhesion characteristics, develops a firm bond between the asphalt and aggregate; displaces water; prevents stripping. Atmospheric conditions have little effect on the adherent properties of the emulsified asphalt: deposition is rapid on either wet or dry surfaces.

In addition to cationic asphalt emulsifiers, Armour also produces Redicote® anti-stripping agents for asphalt cutbacks. The addition of as little as 0.2% Redicote to the asphalt will improve adhesion of asphalt to a wet or dry aggregate surface.

CHEMICALS THAT HELP INHIBIT ACID AND CORROSION

Refiners have found Armour chemicals useful in the field of metal cleaning. Small amounts of Armohib® additives retard acid attack on metals without diminishing the cleaning action of the acids. Armohibs are easy to use; liquid; readily soluble in acids; nonstaining; do not precipitate while standing. They offer users low-cost, dependable acid inhibition over a wide range of temperatures.

In addition, Duomeens and Duomeen salts are effective as refinery corrosion inhibitors. In treating pipe still overheads and light hydrocarbon streams, these chemicals perform efficiently at temperatures of 250-500° F., and concentrations of 6-12 ppm.

REORGANIZATION

The Armour Industrial Chemical Company has reorganized its derivatives department in order to offer you quicker, more expert technical assistance. Your Armour representative is now a member of our newly formed petroleum section—a department composed entirely of petroleum experts...men who know the oil business and understand its problems.

The new home base of this department is in Dallas, Texas, focal point of activity in the oil industry.

Call your petroleum chemical expert today. Let him show you how you can put Armour Idea Chemicals to work—productively...economically. For complete details on Armour Idea Chemicals for oil refining, send the coupon.

Petroleum Chemical Sales Department

Armour Industrial Chemical Company

One of the Armour Chemical Industries

5738 N. Central Expressway/Dallas 6, Texas

ARMOUR INDUSTRIAL CHEMICAL COMPANY
5738 N. Central Expressway, Dallas 6, Texas

Please send me your booklet on Armour Idea Chemicals for Oil Refining.

Name..... Title.....

Company.....

Address.....

City..... Zone..... State.....

For more data on advertised products, use cards, last page.

Hartzell REPORTS ON Air Fin Cooler Fans in Germany

In Germany, the U.S. and around the globe, Hartzell cooling tower and heat exchanger fans are recognized for continuous, trouble-free performance.

At Esso's Refinery in Cologne, Germany, Hartzell six-bladed fan assemblies have been operating since November, 1958, delivering top-notch cooling performance.

Important reasons for this performance bonus are • AUTOMATIC AND INSTANTANEOUS CONTROLLABLE pitch settings that hold outlet temperature fluctuation to ±1½° F by increasing or decreasing blade pitch as cooling requirements change. • Up to 50% POWER SAVING since the pitch of the fan blades is rarely at maximum. • COMPLETE SIZE RANGE.

Whatever your requirement, look to Hartzell for your cooling tower and heater exchanger fans that cover every application. Write for bulletin A-111B.

Hartzell PROPELLER FAN COMPANY
PIQUA, OHIO
HARTZELL

Engineering offices in principal cities
Div. of Castle Hills Corp.

New Equipment . . .

moisture. Compared to ordinary cables, cables insulated with Okonex can carry heavier loads for a given size conductor or the same load on a smaller size conductor.

Engineers will find the data on current carrying capacities, dimensions and the various designs available helpful in designing and specifying efficient electrical systems. The Okonite Co.

Circle E16 green card, last page

Circular Slide Rule Finds Pipe Wrap Costs

A new circular slide rule-calculator tells the corrosion engineer how much pipe line outer wrap he needs for any job, the total cost of his materials, and how he can save from $18 to

$155 per mile by specifying Fiberglas outer wrap. The calculator, which is 6½ inches in diameter, is available free. Owens-Corning Fiberglas Corp.

Circle E17 green card, last page

Catalog Includes Design Details on Unions

An interesting, 16-page catalog describing the company's line of unions and union fittings gives complete details on designs, weights and dimensions. Also included in the booket are engineering specifications, and information on prices, terms and deliveries. Stockham Valves & Fittings.

Circle E18 green card, last page

Questions and Answers About Compressor Valving

The operation and importance of valves in modern reciprocating compressors are described in a new 44-page booklet, "Questions and Answers about Valving."

The booklet details the demands made on valves and their function in a compressor. Since valves must open and close up to 60,000 times per hour,

they are subjected to almost every type of destructive force during their operation. Also, they often must perform in an atmosphere of dirty or corrosive gases. Despite taking this punishment, valves must hold gas pressure during the compression stroke. At the completion of the stroke, they must pop open quickly to release the compressed gas for efficient compressor operation.

. Throughout the booklet, cartoons and cut-away drawings are used to illustrate valve components and mechanics. Ingersoll-Rand.

Circle E19 green card, last page

Pipe Dimension Chart Includes ASA Standards

A new pipe dimension chart shows the outside diameter and wall thickness for all sizes of pipe from ½ through 42 inches. Also included is information from ASA Standard B36. 10, showing IPS and schedule numbers and their relationship together with the latest wall thicknesses added in the 1959 revision.

Suitable for desk or wall mounting, the chart is a convenient reference, eliminating the need for referral to standards booklets. Midwest Piping Div., Crane Co.

Circle E20 green card, last page

Brochure Tells How Solvent Extraction Improves Lube

A new brochure describes the company's line of exclusive, centrifugal contactors, solvent extractors, chemical reactors, separators and clarifiers. The operating principle of these countercurrent, liquid-liquid and vapor-liquid machines is fully described with the help of illustrations and diagrams. A comprehensive section on applications includes process flow diagrams, installation photos, and a full list of operating advantages. Podbielniak, Inc.

Circle E21 green card, last page

Guide to Solvent Storage Covers Tank, Pump Design

A new guide to bulk storage of specially denatured alcohol and proprietary solvents covers government regulations relating to storage of these liquids.

It also has sections devoted to sug-

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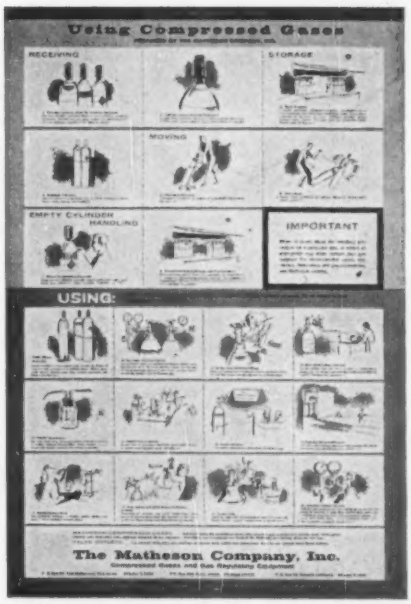
Free Chart shows safe methods of Handling Compressed Gases

This new chart, prepared by Matheson's Technical Department, shows safe methods of handling every gas available in cylinders for laboratory or plant use. Step by step illustrations show correct procedures for Receiving Cylinders, Moving, Handling Empty Cylinders, Using Gases. The 14" x 21" chart is designed for wall mounting wherever gases are received, stored or used. Write for your copy.



New Gas Catalog

Our new catalog gives prices and data on 85 compressed gases, gas mixtures and gas regulating equipment. Available on request.

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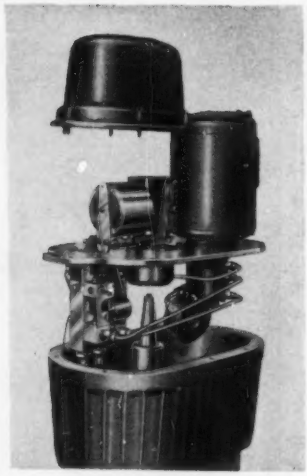

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Exploded view showing arrangement of components on mounting plate. Every part except hydraulic cylinder and piston may be removed as one unit. For periodic maintenance entire unit may be replaced with stand-by assembly in minutes.

PERFORMANCE DATA—TYPE 350
(2,000 lb. thrust unit)*

Stroking Speed—0.37 in/sec
Stalled Stem Thrust—2,000 pounds
Linearity—Better than 2% of full travel
Resolution Sensitivity—Better than 0.05%

Load Sensitivity (Percent of total travel per 100 lbs. load)

Input Signal	Internal Resistance of Actuator	Load Sensitivity
1 to 5 ma DC	2,200 ohm	1.0%
1 to 5 ma DC	12,000 ohm	0.38%
4 to 20 ma DC	260 ohm	0.92%
10 to 50 ma DC	380 ohm	0.3%

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gested tank design, size, and location; auxiliary equipment including pumps, pipe and fittings, valves, electrical grounding procedures, vents, and measuring devices. The bulletin contains drawings of typical above and below ground storage tanks. A typical gauging well and methods of anchoring underground tanks are also illustrated in detail. U.S. Industrial Chemicals Co.

Circle E22 green card, last page

Bulletin Tells How to Find Valve Flow Characteristics

Two methods for determining valve flow characteristics are described in a newly revised bulletin.

Section 1 covers the fundamental method of determining pressure drops for all types and sizes of the company's lubricated plug valves, including the venturi types. General instructions show how to use data from the accompanying pressure drop tables.

Section 2 offers a rapid method of estimating the pressure drop through venturi type valves. Pressure drop valves are visually picked off charts of head loss vs. valve size for both gas and liquid service. Corrections for different conditions of gas and liquid flow can be computed from examples given at the end of this section. Rockwell Mfg. Co.

Circle E23 green card, last page

Roughing Drawings Shown In Gage Valve Catalog

Two new four-page catalogs illustrate and describe the features, styles, sizes and construction details of the company's union bonnet and screwed bonnet liquid level gage valves which assure safe, dependable leak-tight service. Included are roughing drawings and detailed tables of standard and optional features. Jerguson Gage & Valve Co.

Circle E24 green card, last page

Reference Chart Covers ASA B16.5 Valve Material

A quick-reference chart showing pressure-temperature ratings for materials used in steel valves is a condensed version of ASA B16.5-1957. It includes standard ratings for the 300 to 2,500-pound ASA pressure classes. Edward Valves, Inc.

Circle E25 green card, last page

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17—BAKER-PERKINS, wet churn, cap. 900 gal. **NEW 1952.**

SHREDDERS and PRE-SHREDDERS
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BAKER-PERKINS Continuous Pre-Shredder, 15 HP, M/D. **NEW 1952.**

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10—BAKER-PERKINS Vissolver, Size 2-E, 40 HP, M/D.
6—BAKER-PERKINS Dissolver, Size 2-E (large), 20 HP, M/D.

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40—Brosites Dialyzer, web cell, 121 plates each, 60" x 22", filter press, screw actuated, hand operated. **NEW 1953.**

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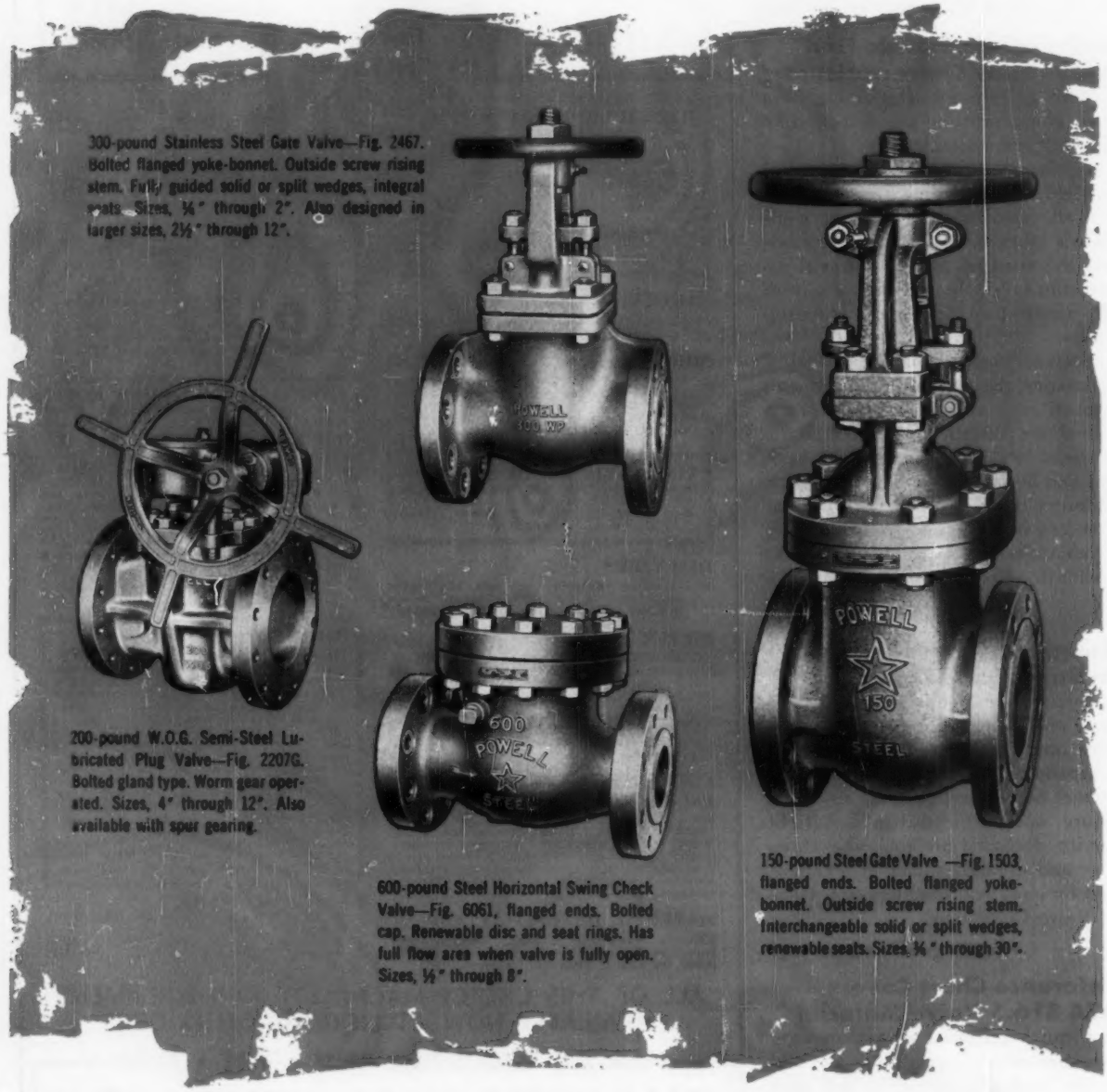

300-pound Stainless Steel Gate Valve—Fig. 2467. Bolted flanged yoke-bonnet. Outside screw rising stem. Fully guided solid or split wedges, integral seats. Sizes, ¼" through 2". Also designed in larger sizes, 2½" through 12".

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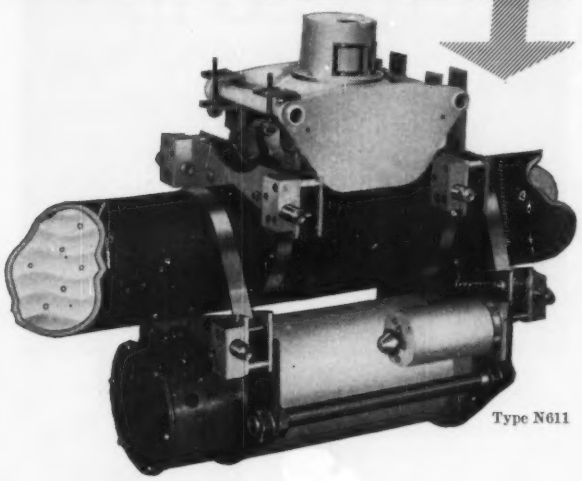

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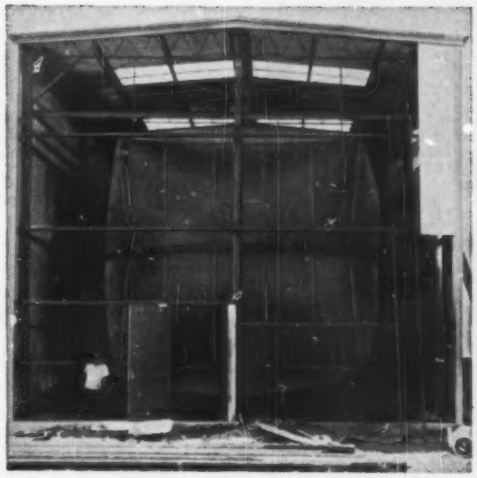

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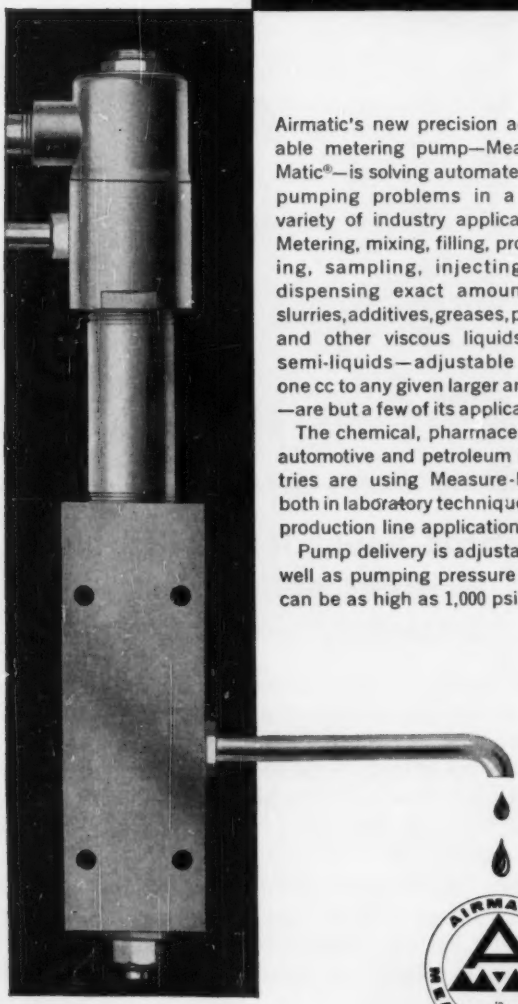

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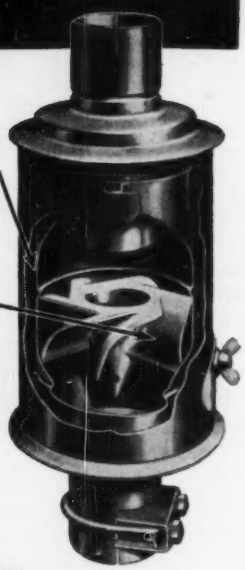

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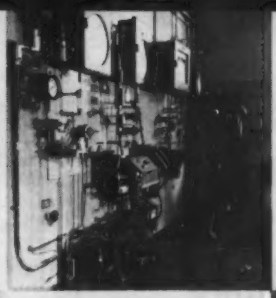

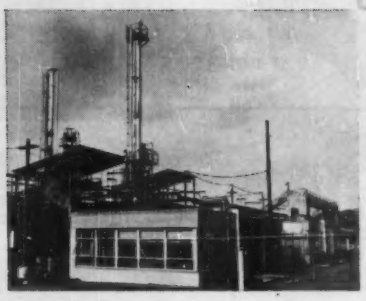

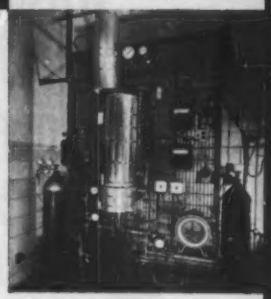

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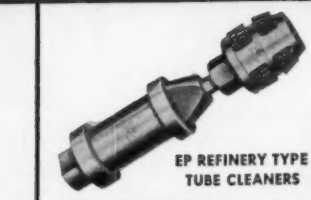

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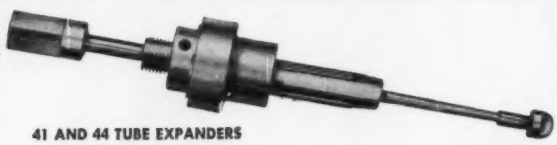

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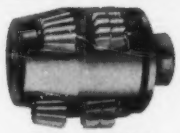

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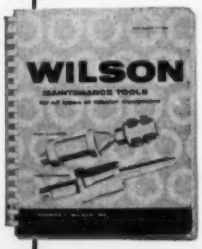

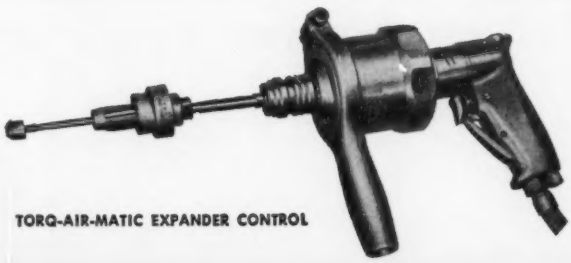

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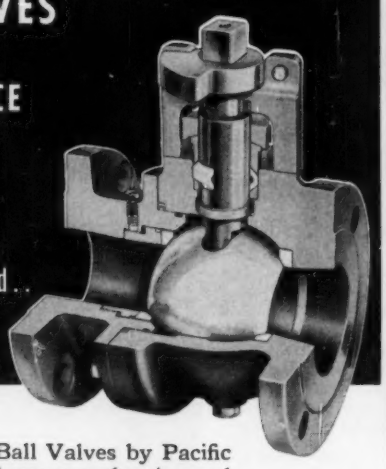

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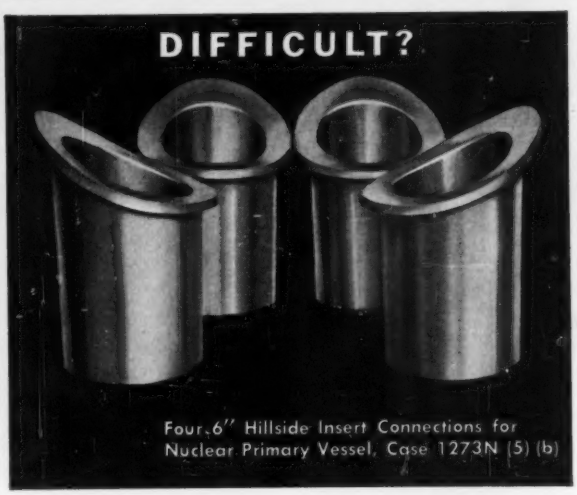

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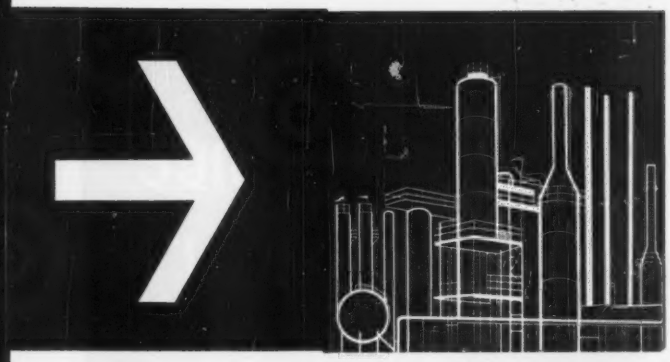

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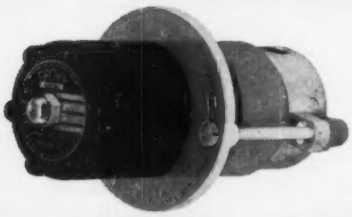

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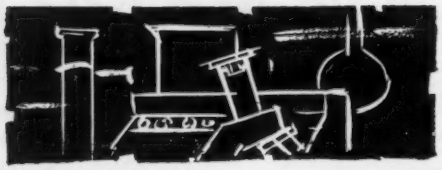

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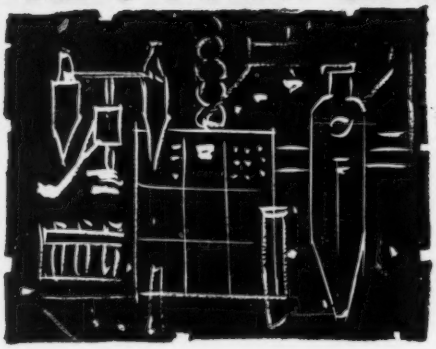

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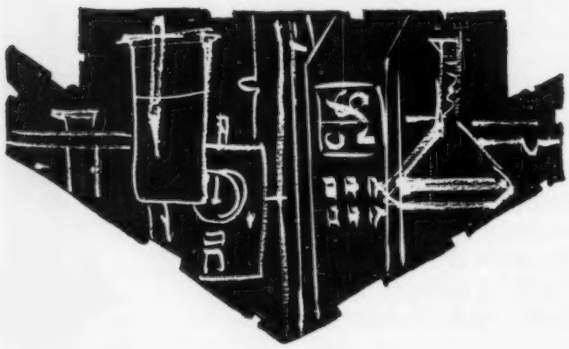

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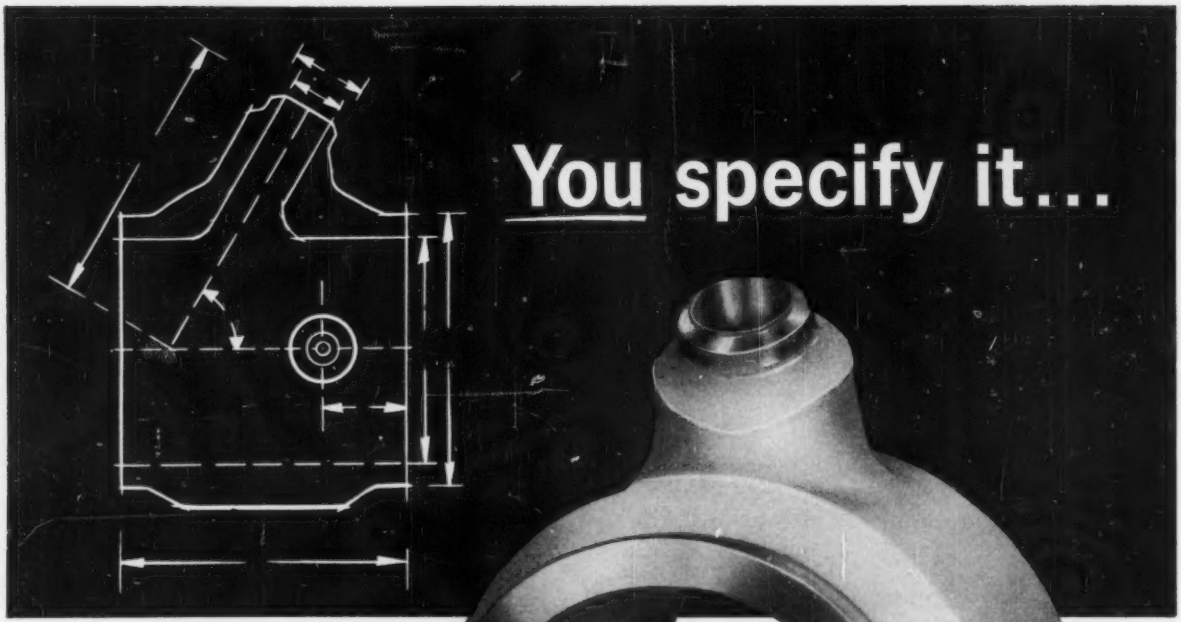

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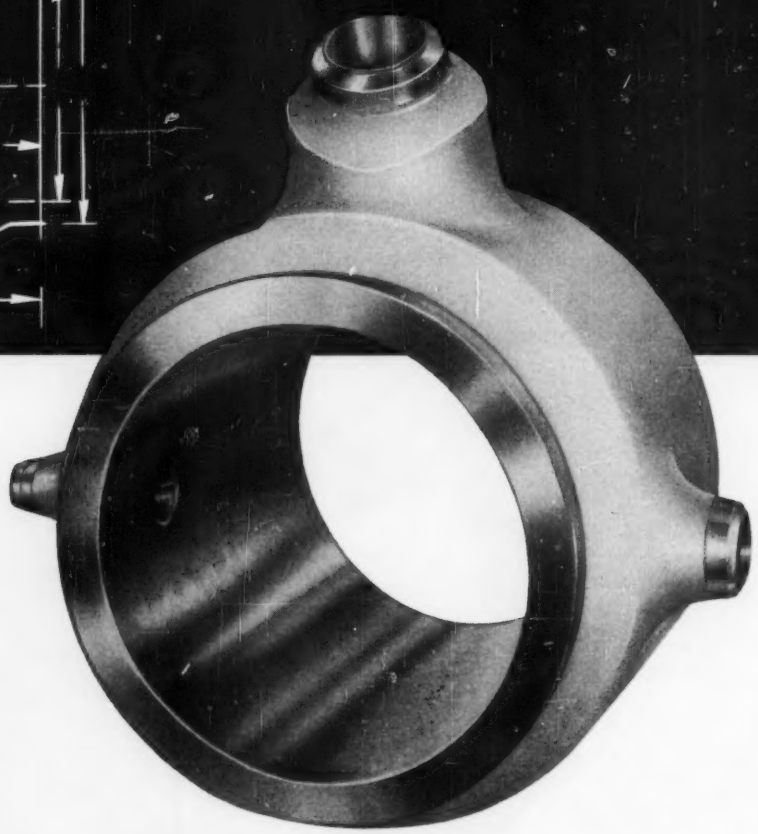

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CHANGES THAT DANGER ZONE TO A SAFETY ZONE

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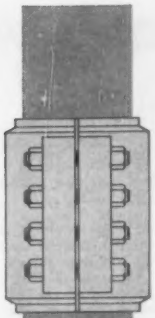
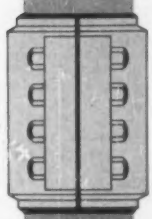
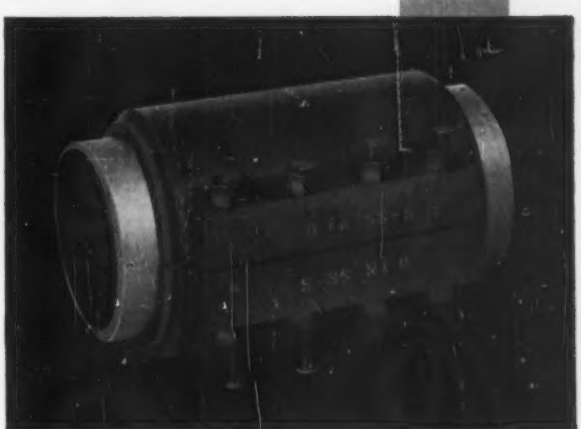

Completed installation


Completed Installation (When welding is Specified)



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Permits welding while pumping.
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290	291	292	293	294	295	296	297	298	299	300a	300b	301a	301b	302a	302b	303	304—305		306
307a	307b	308	309	310	311a	311b	312a	312b	313	314a	314b	314c	315	316a	316b	317	318	319a	319b
319c	323	324																	

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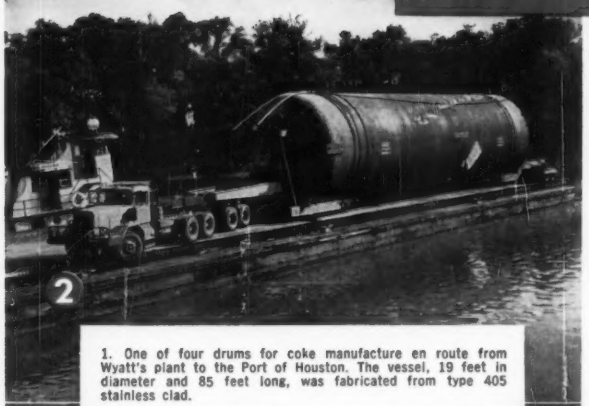

2

1. One of four drums for coke manufacture en route from Wyatt's plant to the Port of Houston. The vessel, 19 feet in diameter and 85 feet long, was fabricated from type 405 stainless clad.

2. Loaded for its barge ride over the Inland Waterway System.

3. Up the Neches River bank at the job site in Beaumont.

3

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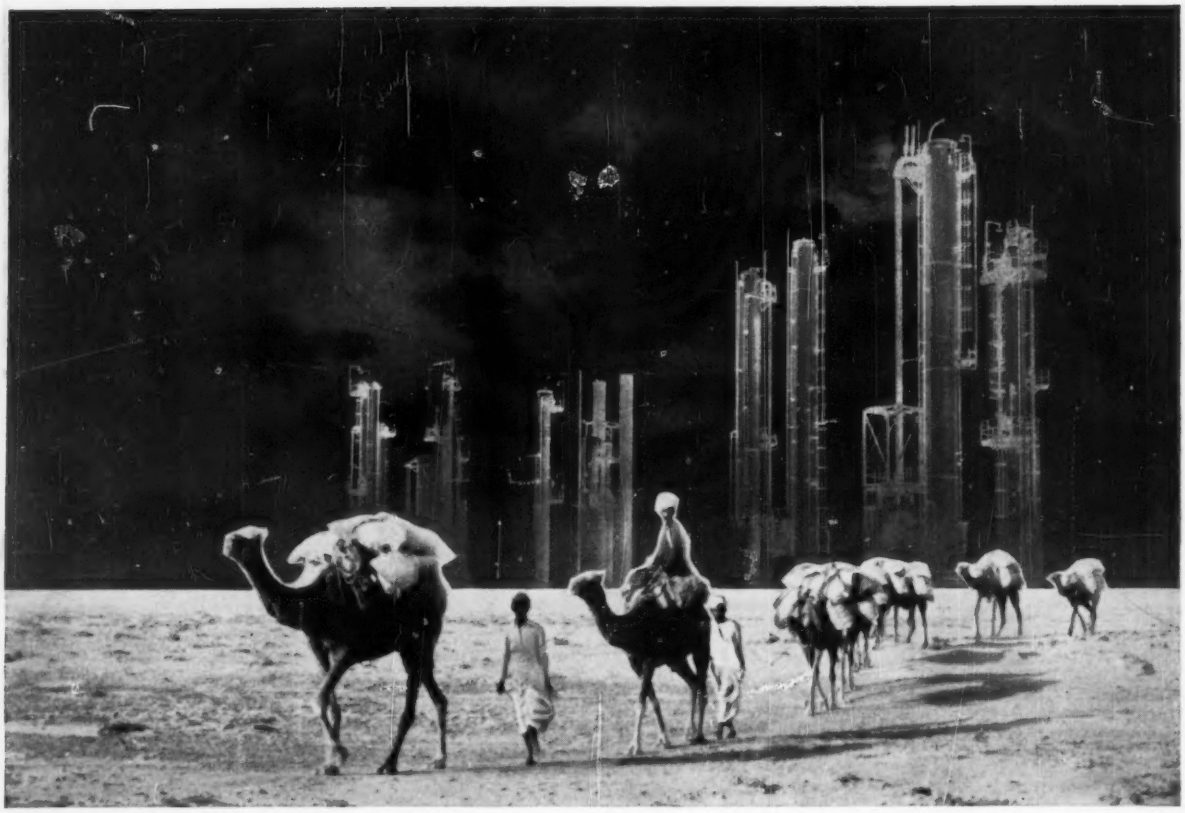

PAKISTAN'S FIRST OIL REFINERY TO BE BUILT BY KELLOGG

for British-Dutch-American consortium

Engineering is well under way at Kellogg for Pakistan's first refinery, near Karachi. Simultaneously, details of procurement—a world-wide operation—are being planned in Kellogg offices. As reported previously, construction is scheduled to begin later this year.

The Kellogg organization will be completely responsible for this 35,000 BPD refinery to Pakistan Refinery Limited. The Burmah Oil Company, Caltex, Shell, Stanvac, together with Pakistani interests, all participate in Pakistan Refinery Limited. Technical coordinator for the consortium is Bataafse Internationale Petroleum Maatschappij.

Important considerations in the selection of the Kellogg organization were cost, speed, ease of maintenance, and the proved ability to undertake and coordinate every phase of engineering, procurement, and construction. Kellogg's contract assures the minimum initial investment and operating costs consistent with good refinery practice and proper safety standards.

For companies considering oil refining or petrochemical manufacturing facilities overseas, Kellogg's international organization offers the optimum return on investments and the soundest kind of economic aid to friendly nations.

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